DOCUMENT RESUME

ED 378 330 CE 067 906

TITLE	Manufacturing (Industrial) Technician.
INSTITUTION	Ohio State Univ., Columbus. Center on Education and Training for Employment.
SPONS AGENCY	Ohio State Dept. of Education, Columbus. Div. of Vocational and Career Education.
PUB DATE	94
NOTE	145p.; In: Tech-Prep Competency Profiles within the Engineering Technologies Cluster; see CE 067 900.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Articulation (Education); Communications; Competence; *Competency Based Education; Computer Assisted Design; *Computer Assisted Manufacturing; Computer Literacy; Drafting; Electricity; Electronic Control; Electronics; *Electronic Technicians; Employment Potential; Equipment Maintenance; High Schools; Industry; Instrumentation; Instrumentation Technicians; *Job Skills; Manufacturing Industry; *Mechanics (Process); Minimum Competencies; Numeracy; Numerical Control; Postsecondary Education; Quality Control; Reading Skills; Safety Education; Science Curriculum; Technical Education; Technology; *Tech Prep; Tool and Die Makers; Troubleshooting; Two Year Colleges

ABSTRACT

This document contains 35 units to consider for use in a tech prep competency profile for the occupation of manufacturing (industrial) technician. All the units listed will not necessarily apply to every situation or tech prep consortium, nor will all the competencies within each unit be appropriate. Several units appear within each specific occupation and would need to only appear once if the user is compiling a cluster of occupations. The first three units are divided into subunits. These units (communications literacy, mathematics literacy, and science literacy) list the competencies for each subunit. The remaining units are divided into competencies, followed by a listing of competency builders. These units are as follows: technology literacy, employability skills, professionalism, teamwork, quality assurance, technical recording and reporting, computer literacy, workplace safety, supervision, basic electronics, fundamentals of electronics technology, troubleshooting and repair, industrial electricity, electrical test and measurement equipment, drafting technology, computer-assisted drafting and design (CADD) fundamentals, equipment installation, equipment maintenance, mechanical power transmission, electromechanical technology, precision machining, fundamentals of machine anatomy, hydraulics and pneumatics, industrial manufacturing technology, programmable logic controllers, computerized numerical control, industrial engineering basics, basic materials science, welding basics, metal stamping dies, press technology, and sheet metal fabrication. (YLB)

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TECH PREP

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Manufacturing (Industrial) Technician

Units to Consider:	Page
Communications Literacy	IM-1
Mathematics Literacy	IM-12
Science Literacy	IM-18
Technology Literacy	IM-29
Employability Skills	IM-30
Professionalism	IM-35
Teamwork	IM-39
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Technical Recording and Reporting	IM-51
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Fundamentals of Machine Anatomy	IM-110
Hydraulics and Pneumatics	IM-111
Industrial Manufacturing Technology	IM-118

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CENTER ON EDUCATION AND TRAINING FOR EMPLOYMENT
COLLEGE OF EDUCATION
THE OHIO STATE UNIVERSITY

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More Units to Consider:	Page
Programmable Logic Controllers (PLCs)	**IM-121**
Computerized Numerical Control (CNC)	**IM-124**
Industrial Engineering Basics	**IM-127**
Basic Materials Science	**IM-129**
Welding Basics	**IM-134**
Metal Stamping Dies	**IM-136**
Press Technology	**IM-140**
Sheet Metal Fabrication	**IM-141**

—NOTICE—

Each Tech-Prep Competency Profile developed should respond to the labor market demands of your Tech Prep Consortium. Therefore, the following pages should be examined carefully before being selected for use in TCP Part I. **[See "The TCP Process" for more information.]** For example, in some cases the number of units far exceeds the amount of content that can be covered within a 4 + 2 TPAD Program. All the units listed in this section will not necessarily apply to your situation, nor will all the competencies within each unit be appropriate. Note that several units appear within each specific occupation and would need to only appear once if you are compiling a cluster of occupations. **[See "TCP Matrix" and "How to Use the TCP Binder" for more information.]**

Unit: Communications Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Language Arts Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Reading—Structure
Competencies:

RS1	Exhibit knowledge of language structure
RS2	Recognize that there may be more than one interpretation of reading selections
RS3	Recognize various literary devices
RS4	Recognize and discuss literary elements
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS6	Apply knowledge of language structure to reading
RS7	Explain why there may be more than one interpretation of reading selections
RS8	Recognize effect of literacy devices on meaning
RS9	Analyze author's use of literary elements
RS10	Recognize relationship of structure to meaning
RS11	Describe various interpretations and meaning levels in reading selections
RS12	Characterize author's use of literary devices
RS13	Characterize use of literary techniques
RS14	Critique a variety of literature with regard to plot, dialogue, theme, setting, and characterization
RS15	Apply an expanding vocabulary gained through reading
RS16	Explain various interpretations and meaning levels in reading selections
RS17	Analyze use of literary techniques (e.g., extended metaphor, simile, personification, hyperbole, pun, alliteration)
RS18	Understand use of literary devices (e.g., irony, satire, allegory, onomatopoeia)
RS19	Analyze and synthesize pieces of literature with regard to plot, dialogue, theme, setting, and characterization

Subunit: Reading—Meaning Construction
Competencies:

RM1	Demonstrate ability to recognize appropriate pre-reading strategies
RM2	Describe effectiveness of a reading selection
RM3	Read to clarify personal thinking and knowledge
RM4	Support interpretation of text by locating and citing specific information
RM5	Develop personal response to a variety of literary works
RM6	Recognize diverse literary interpretations
RM7	Engage in self-selected reading activities
RM8	Confirm and extend meaning in reading by researching new concepts and facts
RM9	Self-monitor and apply corrective strategies when communication has been interrupted or lost
RM10	Use features of literary genres to extend meaning
RM11	Assess effectiveness of a selection read
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge
RM13	Use knowledge of semantic elements (e.g., figurative language, denotation, connotation, dialect) to clarify meaning when reading
RM14	Predict, recognize, interpret, and analyze themes based on familiarity with author's work
RM15	Compare and contrast literary genres
RM16	Assess validity and quality of selection read
RM17	Clarify meaning when reading
RM18	Compare personal reaction to critical assessment of a literary selection
RM19	Assess validity of diverse literary interpretations
RM20	Use reference books to find, evaluate, and synthesize information
RM21	Identify tone of a literary work
RM22	Critique validity of diverse literary interpretations
RM23	Integrate personal reaction to and critical assessment of a literary selection

Subunit: Reading—Application
Competencies:

RA1 Select and read material for personal enjoyment and information
RA2 Read a variety of complete, unabridged works
RA3 Employ various reading strategies according to purpose
RA4 Participate in selection of books, materials, and topics for literature study groups
RA5 Develop and apply knowledge of the interrelationship of concepts
RA6 Read selections from a variety of styles and formats, recognizing that style and format influence meaning
RA7 Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities
RA8 Read extensively from a particular author's work and explain elements of author's style

Subunit: Reading—Multidisciplinary
Competencies:

RM1 Connect themes and ideas across disciplines through literature
RM2 Read to facilitate learning across curriculum
RM3 Read to develop awareness of human rights and freedom
RM4 Participate actively in a community of learners
RM5 Recognize and explain interaction between literature and various cultural domains (e.g., social technological, political, economic)
RM6 Explore and analyze a variety of cultural elements, attitudes, beliefs, and value structures by men and women of many racial, ethnic, and cultural groups
RM7 Value thinking and language of others
RM8 Relate literature to historical period about which or in which it was written
RM9 Read to facilitate content learning

Subunit: Writing—Structure
Competencies:

WS1	Develop and expand a repertoire of organizational strategies (e.g., narration, comparison/contrast, and description) through a practice and discussion
WS2	Clarify word choice according to audience, topic, and purpose
WS3	Locate and correct errors in usage, spelling, and mechanics using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing which contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS6	Use information from a variety of sources to develop an integrated piece of writing
WS7	Evaluate and revise writing to focus on such things as audience, tone, and purpose
WS8	Recognize differences between documentation and reference list styles
WS9	Develop extended pieces of writing which contain ordered, related, well-developed paragraphs with sentences of varied lengths and patterns
WS10	Select from a repertoire of organization strategies a pattern appropriate to a topic
WS11	Synthesize information from a variety of sources
WS12	Refine word choice and tone according to audience, situation, and purpose
WS13	Appropriately cite information gained from primary and secondary sources
WS14	Use style manuals or software to prepare documentation and reference lists
WS15	Develop effectively organized pieces of expository writing containing strong voice, clear thesis, and well-developed ideas
WS16	Identify organization patterns appropriate to writing topic
WS17	Respond to others' suggested revisions to a writing piece

Subunit: Writing—Meaning Construction
Competencies:

WM1	Demonstrate knowledge of the recursive nature of the writing process by applying it appropriately to various topics, situations, and audiences
WM2	Develop criteria for writing evaluation using scoring guides and peer/teacher assistance to clarify meaning
WM3	Respond to others' suggested revisions to a piece of writing
WM4	Use word processing, graphics, and publishing aids to construct meaning in writing
WM5	Engage in self-initiated writing activities
WM6	Incorporate personal criteria with generally accepted standards for writing evaluation
WM7	Evaluate, analyze, and synthesize information for writing
WM8	Evaluate own writing using personal and established scoring criteria
WM9	Assess personal/peer revisions to a writing piece
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application
Competencies:

WA1	Apply appropriate writing techniques suitable for varied writing tasks
WA2	Use sentence-combining techniques to improve syntactic fluency and maturity
WA3	Write in response to prompted and self-selected topics in practical, persuasive, descriptive, narrative, and expository domains
WA4	Develop personal voice in writing
WA5	Consider audience and purpose for writing
WA6	Develop criteria for selection and potential development of topic
WA7	Write in a journal or learning log to clarify personal thinking and knowledge
WA8	Apply an expanding vocabulary gained through writing
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, on-lien data base, encyclopedia)
WA10	Demonstrate, an appreciation for aesthetically pleasing language through word choice and style
WA11	Apply revising and editing strategies needed for writing task
WA12	Vary sentence lengths and patterns
WA13	Refine personal voice in writing
WA14	Vary styles and formats for intended purpose and audience
WA15	Apply criteria for selection and development of topic
WA16	Participate in peer review of writing in progress
WA17	Use transitions between sentences, ideas, and paragraphs in writing
WA18	Revise and edit papers extensively in preparation for presentation/publication
WA19	Develop a variety of genres
WA20	Focus writing and tone on such elements as audience, situation, and purpose
WA21	Develop topic fully and appropriately
WA22	Use writing process to clarify personal thinking and knowledge
WA23	Apply appropriate recursive writing process as suggested by writing task and writer's process
WA24	Develop an extended piece of writing
WA25	Revise writing and tone to assure focus on such elements as audience, situation, and purpose
WA26	Use writing process to write reflectively

Subunit: Writing—Multidisciplinary
Competencies:

WM1 Use writing process for learning across curriculum
WM2 Use writing process to demonstrate knowledge of need for human rights and freedom
WM3 Value and apply collaborative skills in writing process
WM4 Write in response to reading, speaking, viewing, and listening
WM5 Use multidisciplinary resources in writing projects
WM6 Use writing process to facilitate learning across curriculum
WM7 Recognize value of and engage in collaboration in writing process
WM8 Use communication processes to develop a published writing piece in collaboration with others
WM9 Record experiences and observations related to content learning
WM10 Apply collaborative skills in writing process
WM11 Write collaboratively with peers
WM12 Use cross-disciplinary resources in writing projects

Subunit: Listening/Visual Literacy—Structure
Competencies:

LS1 Listen to and view a wide variety of genres
LS2 Become aware of an author's style through listening and viewing a variety of works
LS3 Recognize correct and appropriate grammar, diction, and syntax
LS4 Expand vocabulary through listening to and viewing varied media
LS5 Recognize beauty of language
LS6 Enhance recognition of an author's style through listening and viewing a variety of works
LS7 Recognize use and misuse of language in media
LS8 Refine knowledge of style through listening and viewing multiple works by the same author
LS9 Expand and refine grammar, diction, and syntax through listening
LS10 Compare authors' styles through viewing and listening to their works
LS11 Expand knowledge of complex grammar, diction, and syntax issues

Subunit: Listening/Visual Literacy—Meaning Construction
Competencies:

LM1 Develop critical thinking skills necessary to evaluate media and assess oral presentations
LM2 Compare new oral texts to past experiences and knowledge in order to enhance comprehension
LM3 Recognize how rhythmic patterns, silence, and cadences enhance quality of speech and literature
LM4 Focus listening and viewing on themes and/or plots
LM5 Gather information from listening and viewing experiences to enhance research
LM6 Use critical thinking skills to evaluate media and oral presentations
LM7 Use prior knowledge and experiences to facilitate comprehension of new oral texts
LM8 Identify rhythmic and time patterns in speech and literature
LM9 Identify and analyze themes and/or plots when listening and viewing
LM10 Use information gathered from listening and viewing experiences to expand research
LM11 Enhance use of critical thinking skills to evaluate media and oral presentations
LM12 Consider prior knowledge and experiences when attempting to understand the meaning of new texts
LM13 Appreciate rhythmic and time patterns of speech and literature
LM14 Select viewing and listening materials to support written text
LM15 Evaluate media and oral presentations analytically and critically
LM16 Organize prior knowledge and experiences to comprehend new texts
LM17 Organize and use viewing and listening materials to support written text

Subunit: Listening/Visual Literacy—Application
Competencies:

LA1 Listen attentively during oral reading
LA2 Use media as stimuli for learning and thinking
LA3 Develop knowledge of structure through art, music, and literature
LA4 Use electronic media to enhance and highlight language learning
LA5 Listen and view for entertainment and enjoyment
LA6 Use technology and other media as means of expressing ideas

Subunit: Listening/Visual Literacy—Multidisciplinary
Competencies:

LM1 Facilitate learning across curriculum through critical listening and viewing
LM2 Engage in individual, small-group, and whole-group listening and viewing activities
LM3 Develop language arts (e.g., viewing, listening) projects collaboratively
LM4 Investigate language and cultural differences through listening and viewing activities
LM5 Participate in a community of learners through productive listening

Subunit: Oral Communication—Structure
Competencies:

OS1 Refine oral communication skills
OS2 Demonstrate knowledge of grammar, usage, and syntax when presenting
OS3 Select topics and vocabulary suitable to audience
OS4 Organize notes and ideas for speaking
OS5 Use language imaginatively
OS6 Modulate voice to meaning when interpreting literature orally
OS7 Organize notes and ideas for formal, semiformal and informal presentations of information
OS8 Refine speaking techniques for formal, semiformal, and informal settings
OS9 Develop repertoire of organizational strategies for presenting information orally
OS10 Expand vocabulary to fit topic
OS11 Select topics suitable to audience, situation, and purpose
OS12 Select appropriate strategies when organizing notes and ideas for speaking

Subunit: Oral Communications—Meaning Construction
Competencies:

OM1 Make connections between prior knowledge and new information for oral presentations
OM2 Participate in informal speaking activities
OM3 Use interviewing techniques to gather information
OM4 Communicate orally to entertain and to inform
OM5 Participate in group communication activities
OM6 Take and organize notes when preparing speech/presentation
OM7 Interpret texts orally to illustrate meaning
OM8 Respond to needs of various audiences
OM9 Gather and assess information for speaking
OM10 Communicate orally to inform and persuade
OM11 Prepare and deliver formal speech/presentation
OM12 Participate in a variety of oral interpretations
OM13 Assess needs of audience and adjust language and presentation according to their knowledge
OM14 Analyze and synthesize information for speaking
OM15 Describe effectiveness of literary selection
OM16 Describe topic or idea in order to clarify personal/audience thinking
OM17 Analyze and synthesize information gathered from a variety of sources for speaking
OM18 Describe validity and/or quality of a literary selection and justify selection
OM19 Interpret orally a variety of literature
OM20 Describe topic or idea to clarify meaning for others

Subunit: Oral Communication—Application
Competencies:

OA1 Become proficient at using interviewing techniques
OA2 Give an oral interpretation for a specific audience
OA3 Develop and apply oral communication skills for cooperative/collaborative learning
OA4 Use oral communication for a variety of purposes and audiences (e.g., negotiations, book reviews, rationales)
OA5 Develop and apply decision-making strategies
OA6 Practice interviewing techniques
OA7 Apply interviewing techniques to purposeful interviews
OA8 Focus oral interpretation on a specific audience

Subunit: Oral Communications—Multidisciplinary
Competencies:

OM1 Value thinking and language of others
OM2 Develop oral projects collaboratively
OM3 Be involved in individual, small-group, and whole-group language activities
OM4 Participate actively in a community of learners
OM5 Investigate language and cultural differences through oral language activities

Unit: Mathematics Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Model Mathematics Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Numbers and Number Relations
Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers
NR3	Compare and contrast real number system, rational number system, and whole number system
NR4	Extend knowledge to complex number system and develop facility with its operation

Subunit: Measurement
Competencies:

M1	Estimate and use measurements
M2	Understand need for measurement and probability that any measurement is accurate to some designated specification
M3	Understand and apply measurements related to power and work
M4	Understand and apply measurement concepts of distance-rate-time problems and acceleration problems
M5	Use real experiments to investigate elasticity, heat, sound, electricity, magnetism, light, acceleration, velocity, energy, and gravity
M6	Use real-world problem situations involving mass and weight
M7	Use real-world problem situations involving simple harmonic motion
M8	Establish ratios with and without common units
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M10	Understand and solve rate-change problems
M11	Understand and solve right triangle relationships as they relate to measurement, specifically to Pythagorean theorem
M12	Graph and interpret ordered pairs
M13	Compute total sales from a variety of items
M14	Comprehend and compute rates of growth or decay
M15	Comprehend, compute, and interpret real problems involving annuities

Subunit: Measurement (continued)
Competencies:

M16 Develop an ability to identify real problems and provide possible solutions
M17 Express and apply different types of measurement scales
M18 Identify area and volume

Subunit: Estimation and Mental Computation
Competencies:

E1 Use estimation to eliminate choices in multiple-choice tests
E2 Use estimation to determine reasonableness of problem situations in a wide variety of applications
E3 Estimate shape of graphs of various functions and algebraic expressions
E4 Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability
Competencies:

D1 Organize data into tables, charts, and graphs
D2 Understand and apply measures of central tendency, variability, and correlation
D3 Use curve fitting to predict from data
D4 Use experimental or theoretical probability, as appropriate, to represent and solve problems involving uncertainty
D5 Use computer simulations and random number generators to estimate probabilities
D6 Test hypotheses using appropriate statistics
D7 Read, interpret, and use tables, charts, and graphs to identify patterns, note trends, draw conclusions, and make predictions
D8 Identify probabilities of events involving unbiased objects
D9 Use sampling and recognize its role in statistical claims
D10 Design a statistical experiment to study problem, conduct experiment, and interpret and communicate outcomes
D11 Describe normal curve in general terms and use its properties
D12 Create and interpret discrete probability distributions
D13 Understand concept of random variable
D14 Apply concept of random variable to generate and interpret probability distributions, including binomial, uniform, and chi square

Subunit: Algebra
Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A2	Use language and notation of functions in symbolic and graphing settings
A3	Recognize and use equivalent zeros of a function, roots and the solution of an equation in terms of graphical and symbolic representations
A4	Describe and use logic of equivalence in working with equations, inequalities, and functions
A5	Develop graphical techniques of solution for problem situations involving functions
A6	Explore and describe characterizing features of functions
A7	Make arguments and proofs in algebraic settings
A8	Factor difference of two squares
A9	Identify slope, midpoint, and distance
A10	Explore and combine rational functions
A11	Explore factoring techniques
A12	Solve quadratic equations by factoring and formula
A13	Set up and solve linear equations
A14	Solve systems of linear equations with two variables
A15	Describe geometric situations and phenomena using variables, equations, and functions
A16	Describe measures of central tendency, mean, median, mode, and variance algebraically and graphically
A17	Represent inequalities on number line and in coordinate plane
A18	Use coordinate arguments in making geometric proofs
A19	Symbolize transformations of figures and graphs
A20	Explore geometric basis for functions of trigonometry
A21	Graph linear functions
A22	Develop and use vectors to represent direction and magnitude including operations
A23	Use polar and parametric equations to describe, graph, and solve problem situations
A24	Represent sequences and series as functions both algebraically and graphically
A25	Explore recursive functions and procedures using spreadsheets, other computer utilities, and appropriate notions
A26	Describe and solve algebraic situations with matrices
A27	Describe and use inverse relationship between functions including exponential and logarithmic

Subunit: Algebra (continued)
Competencies:

A28	Analyze and describe errors and error sources that can be made when using computers and calculators to solve problems
A29	Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A30	Explore relationships between complex numbers and vectors
A31	Make arguments concerning limits, convergence and divergence in context involving sequences, series, and other types of functions
A32	Represent transformations in plane with matrices
A33	Contrast and compare algebra's of rational, real, and complex numbers with characteristics of a matrix algebra system
A34	Construct polynomial approximations of a function over specified intervals of convergence
A35	Examine complex numbers as zeros of functions
A36	Translate verbal statements into symbolic language
A37	Simplify algebraic expressions
A38	Use laws and exponents (including scientific notation)
A39	Expand and extend idea of vectors and linear algebra to higher dimensional situations
A40	Use the idea of independent basis elements for a vector space and associated fundamental concepts of finite dimensional linear algebra
A41	Develop and communicate arguments about limit situations
A42	Use matrices to describe and apply transformations
A43	Develop and use polar and parametric equations to represent problem situations
A44	Explore proofs by mathematical induction

Subunit: Geometry
Competencies:

G1	Create and interpret drawings of three-dimensional objects
G2	Represent problem situations with geometric models and apply properties of figures
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G5	Explore inductive and deductive reasoning through applications to various subject areas
G6	Translate between synthetic and coordinate representations
G7	Identify congruent and similar figures using transformation with computer programs
G8	Deduce properties of figures using transformations and coordinates
G9	Use deductive reasoning
G10	Explore compass and straightedge constructions in context of geometric theorems
G11	Demonstrate knowledge of and ability to use proof
G12	Use variety of proof techniques (e.g., synthetic, transformational, and coordinate)
G13	Use variety of proof formats, including T-proof (i.e., two-column) and paragraph proof
G14	Explore different proof strategies
G15	Investigate different proofs of theorems
G16	Develop knowledge of an axiomatic system
G17	Apply transformations and coordinates in problem solving
G18	Represent problem situations with geometric models and apply properties of figures
G19	Deduce properties of figures using vectors
G20	Analyze properties of Euclidean transformations and relate translations to vectors
G21	Apply vectors in problem solving
G22	Develop further knowledge of axiomatic systems by investigating and comparing various geometry's

Subunit: Patterns, Relations, and Functions
Competencies:

P1	Model real-world phenomena with polynomial and exponential functions
P2	Explore relationship between zeros and intercepts of functions
P3	Translate among tables, algebraic expressions, and graphs of functions
P4	Use graphing calculator or computer to generate graph of a function
P5	Explore relationship between a linear function and its inverse
P6	Describe and use characteristics of polynomial functions in problem-solving situations
P7	Explore conic sections and graph using graphing calculator or computer
P8	Apply trigonometric functions to problem situations involving triangles
P9	Discover relationships between algebraic description, kind, and properties of conic
P10	Explore periodic real-world phenomena using sine and cosine functions
P11	Analyze effects of parameter changes on graphs
P12	Use graphing calculator or computer to graph functions
P13	Develop an knowledge of rational and transcendental functions
P14	Understand connections between trigonometric and circular functions
P15	Use circular functions to model periodic real-world functions
P16	Solve trigonometric equations and verify trigonometric identities
P17	Understand connections between trigonometric, exponential, and logarithmic functions and polar coordinates, complex numbers, and series
P18	Model real-world phenomena with a variety of functions
P19	Graph using polar coordinates
P20	Explore graphs in three dimensions
P21	Explore functions of several variables
P22	Explore recursive functions using spreadsheets and/or programming languages

Unit: Science Literacy

NOTE: This content was extracted from the 9-12 cluster of Ohio's Draft Model Science Program. Due to statewide initiatives other than Tech Prep, this literacy unit was not altered to meet competency-based criteria. Each literacy unit forms a critical link between academic teachers and members of business, industry, and labor. [See "The TCP Process" for more information.]

Subunit: Scientific Inquiry
Competencies:

- Q1 Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
- Q2 Use ratios, proportions, and probabilities in appropriate problem situations
- Q3 Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
- Q4 Use existing algebraic formulas and create new ones in appropriate problem-solving situations
- Q5 Estimate and justify probabilities of outcomes of familiar situations based on experimentation and other strategies
- Q6 Invent apparatus and mechanical tools needed to perform unique tasks in various situations
- Q7 Identify, compare, and contrast different modes of inquiry, habits of mind, and attitudes and dispositions
- Q8 Design investigations that are safe and ethical (i.e., obtain consent and inform others of potential outcomes, risks and benefits, and show evidence of concern for human health and safety, concern for non-human species)
- Q9 Make and read scale drawings, maps, models, and other representations to aid planning and understanding
- Q10 Seek elaboration and justification of data and ideas, and reflect on alternative interpretations of the information
- Q11 Use appropriate units for counts and measures
- Q12 Create and use databases (electronic and other) to collect, organize, and verify data and observations
- Q13 Design and conduct investigations with multiple variables
- Q14 Communicate the results of investigations clearly in a variety of situations

Subunit: Scientific Inquiry (continued)
Competencies:

Q15 Examine relationships in nature, offer alternative explanations for the observations, and collect evidence that can be used to help judge among explanations

Q16 Trace the development (e.g., history, controversy, and ramifications) of various theories, focusing on supporting evidence and modification with new evidence

Q17 Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements

Q18 Observe and document events and characteristics of complex systems

Q19 Explain the influence of perspective (e.g., spatial, temporal, and social) on observation and subsequent interpretations

Q20 Create multiple representations of the same data using a variety of symbols, descriptive languages, mathematical concepts, and graphic techniques

Q21 Generate testable hypotheses for observations of complex systems and interactions

Q22 Document potentially hazardous conditions and associated risks in selected homes and public areas

Q23 Participate in public debates, relying on documented and verified data to construct and represent a position on scientific issues

Q24 Construct and test models of physical, biological, social, and geological systems

Q25 Read, verify, debate, and, where necessary, refute research published in popular or technical journals of science (e.g., *Discover*, *Omni*, *Popular Mechanics*)

Q26 Explore discrepant events and develop and test explanations of what was observed

Q27 Conduct theory-based research using surveys, observational instruments, and other methods

Q28 Modify personal opinions, interpretations, explanations, and conclusions based on new information

Q29 Analyze error and develop explanations in various domains

Q30 Formulate taxonomic schemes based upon multivariate models that help to explain similarities and differences in form, distribution, behavior, survival, and origin of objects and organisms

Q31 Demonstrate various logical connections between related concepts (e.g., entropy, conservation of energy)

Q32 Account for discrepancies between theories and observations

Q33 Analyze the changes within a system when inputs, outputs, and interactions are altered

Subunit: Scientific Inquiry (continued)
Competencies:

Q34 Create, standardize, and document procedures

Q35 Determine the sources of significant disparities between the predicted and recorded results and change research procedures to minimize disparities

Q36 Research, locate, and propose applications for abstract patterns (e.g., fractals, Fibonacci sequences, string theory, orbitals)

Q37 Recognize and utilize classification systems for particles, elements, compounds, phenomena, organisms, and others for exploring and predicting properties and behaviors

Q38 Suggest and defend alternative experimental designs and data explanations (e.g., sampling, controls, safeguards)

Q39 Recognize and communicate differences between questions that can be investigated in a scientific way and those that rely on other ways of knowing

Q40 Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Q41 Suggest new questions as a result of reflection on and discussions about their own scientific investigations

Q42 Investigate, assess, and comment on strengths and weakness of the descriptive and predictive powers of science

Q43 Create new information from representations of data in a variety of forms (e.g., symbols, descriptive languages, graphic formats) utilizing a variety of techniques (e.g., interpolations, extrapolations, linear regressions, central tendencies, correlation's)

Subunit: Scientific Knowledge
Competencies:

K1 Investigate various types of dynamic equilibrium (e.g., biological, geological, mechanical, chemical)

K2 Investigate the relationship between the rates of energy exchange and the relative energy level of components with systems (e.g., tropic levels of ecosystems, osmosis, rate of heating and cooling, storms)

K3 Investigate patterns in the natural world (e.g., heredity, crystalline structures, population and resource distributions, diffraction, dispersion, polarization)

K4 Investigate models and theories that help to explain the interactions of components in systems (e.g., conservation of mass, energy, and momentum; food webs; natural selection; entropy; plate tectonics; chaos; relativity; social-psychology)

K5 Investigate degrees of kinship among organisms and groups of organisms

K6 Investigate the limits of the definition of life, and investigate organisms and physical systems that exist at or near these limits (e.g. viruses, quarks, black holes)

K7 Investigate estimates and measurements of a wide range of distances and rates of change

K8 Investigate the historical development of theories of change over time (e.g., natural selection, continental drift, the big bang, geologic change)

K9 Investigate physical and chemical changes in living and non-living systems (e.g., photosynthesis, weathering processes, glaciation, thermal effects of materials, energy cells)

K10 Investigate simulations of nuclear change (e.g., radioactivity, half life, carbon dating)

K11 Investigate conservation principles associated with physical, chemical, and nuclear changes

K12 Formulate descriptions of the impacts of various forms of mechanical and electromagnetic waves on various organisms on each other over time

K13 Formulate models and hypotheses for patterns in the natural world (e.g., earth structures, transportation systems, migrations, communications, constellations)

K14 Formulate explanations for the influences of objects and organisms on each other over time

K15 Formulate and interpret explanations for change phenomena (e.g., mass extinction's, stellar evolution, punctuated equilibrium, molecular synthesis)

Subunit: Scientific Knowledge (continued)
Competencies:

K16 Formulate and interpret explanations for the magnitudes of diversity at different periods of geologic time (e.g., mutation, global cataclysms, continental drift, competition, mass extinction's)

K17 Formulate interpretations of the structure, function, and diversity in a variety of organisms and physical systems (e.g., DNA and RNA variants, nucleons, interaction particles)

K18 Formulate understandings of geologic time (e.g., millennia, periods, epochs)

K19 Formulate an understanding of the historical development of the model of the universe

K20 Formulate explanations and representations of the production, transmission, and conservation of energy in biological and physical systems (e.g., weather, volcanism, earthquakes, electricity, magnetism, cellular respiration)

K21 Formulate models and hypotheses about patterns in the natural world (e.g., social behavior, molecular structure, energy transformation, entropy, randomness, aging, chaos, hormonal cycles)

K22 Formulate interpretations of the relationship between energy exchange and the interfaces between components within systems

K23a Formulate estimations for the range of energies within and between various phenomena (e.g., thermal, electromagnetic, thermonuclear, chemical, electrical)

K23b Formulate explanations for the historical development of descriptions of motions interactions and transformations of matter and energy (e.g., classical Newtonian mechanics, special and general relativity, chaos)

K24 Formulate models that can be used to describe fundamental molecular interactions in living and non-living systems (e.g., cell membranes, semiconductors).

K25 Formulate an understanding of the degree of relationship among organisms and objects based on molecular structure (e.g., proteins, nucleic acids)

K26 Formulate hypotheses and models that may account for observable events (e.g., electricity and magnetism, gravitation, atoms, bonding, chemical reactions, quantum effects, energy flow on biological systems, predator-prey relationships)

K27 Formulate models and hypotheses about change over time (e.g., natural selection, speciation, punctuated equilibrium, phyleytic gradualism, stellar evolution, plate tectonics, radioactive decay, quantum mechanical theory)

Subunit: Scientific Knowledge (continued)
Competencies:

K28 Formulate lists of limitations and propose refinements of standard classification systems (e.g., periodic table, IUPAC, Linnean, standard model)

K29 Formulate specific cases of limitations and possible exceptions of theories and principles regarding the interactions of moving objects and organisms (e.g., fluid flow in vessels, motion near the speed of light, Heisenberg uncertainty principle, meteorological prediction, local variation and diversity, predicting earthquakes, energy transport in cellular respiration)

K30 Formulate plans and contingencies that can be used to accommodate for changes to and stresses on systems (e.g., wildlife and habitat management, corrosion prevention, noise abatement, structure design)

K31 Formulate models of molecular, atomic, ionic, and subatomic structures and the physical and biological implications of these structures (e.g., genes, nucleons, quarks)

K32 Formulate estimates for a wide range of measurements and scales (e.g., angstroms to light years)

K33 Formulate and interpret representations of time from origin to present accounting for phenomena of scale (e.g., smoothness, punctuation's, chaos)

K34 Formulate interpretations of the historical development of various theories of possible causes of diversity among physical and biological phenomena (e.g., the works of Aristotle, Mendel, Darwin, McClintock)

K35 Formulate models and hypotheses that can be used to explain the interactions of components within technological and ecological systems

Subunit: Conditions for Learning Science
Competencies:

C1	Participate actively in dialogue about and resolution of community issues
C2	Assess information from various countries in the original language or translated form to ascertain the perspectives of many cultures
C3	Analyze the scientific ideas presented in science fiction stories and films
C4	Perform and repeat investigations to verify data, determine regularity, and reduce the impact of experimental error
C5	Present the results of investigations in a variety of forums
C6	Contribute to the decisions regarding topics for investigation
C7	Use various creative means to communicate interpretations of scientific ideas, concepts, phenomena, and events
C8	Consider the scientific thinking and language of others
C9	Individually and collaboratively produce clearly written representations of investigative results
C10	Fulfill responsibilities as part of a research group
C11	Select and utilize resources by various criteria (e.g., efficiency, effectiveness, health, safety) that are appropriate to the investigations being conducted by groups
C12	Present persuasive argument based on the scientific aspects of controversial issues
C13	Collect, store, retrieve, and manipulate information with available t technologies alleges that may range from hand processes up through computer applications
C14	Investigate social issues with a scientific perspective (e.g., human rights, wellness, economics, futurism, environmental ethics)
C15	Keep journals of observations and inferences made over an extended period of time and reflecting upon the impact of these recorded ideas on their thinking and actions
C16	Examine the intellect, perspectives, and ethics of notable scientists
C17	Collect and analyze observations made over extended periods of time and compare these to scientific theories
C18	Create presentations of scientific understandings using diverse modes of expressions
C19	Conduct formal scientific debates in the classroom
C20	Wonder about the likelihood of events that may occur by chance or coincidence
C21	Plan and conduct field trips and experiences for small and large groups
C22	Analyze the historical context which leads to and has lead to scientific t theories

Subunit: Conditions for Learning Science (continued)
Competencies:

C23 Seek information on topics of personal scientific interest from a variety of sources
C24 Conduct learner-developed investigations independently and collaboratively over periods of week and months
C25 Listen attentively and critically to presentations of scientific information made by others
C26 Conduct analyses of propaganda related to scientific issues
C27 Perform investigations that require observations over varying periods of time
C28 Experience scientific concepts as interpreted by other cultures through multimedia and local and global specialists
C29 Access appropriate technology to perform complicated, time-consuming tasks
C30 Relate historical accounts of science to the cultural context in which they were written
C31 Work as a contributing member of a collaborative research group
C32 Examine the influences of social and political structures and realities that contribute to inquiry about scientific issues
C33 Use technology (e.g., desktop publishing, teleconferencing, networking) to communicate scientific ideas
C34 Explore and analyze a variety of perspectives on science (e.g., works by men and women of many racial, ethnic, and cultural groups)
C35 Lead groups of learners of various ages in designing, planning, and conducting science activities
C36 Respect the scientific thinking of others and self
C37 Recognize and contrast different epistemologies
C38 Develop possible courses of action in response to scientific issues of local and global concern
C39 Determine the validity of research conclusions in relation to the design, performance, and results
C40 Develop multimedia presentations of group and individual research projects and investigations appropriate for a variety of audiences and forums
C41 Produce interesting and scientifically correct stories and present them using various modes of expression
C42 Reflect on the ideas and content found in their own journal records
C43 Examine ambiguous results and formulate explanations
C44 Recognize and synthesize the contributions to scientific thought of individuals from many cultures

Subunit: Conditions for Learning Science (continued)
Competencies:

C45 Construct models and simulations of the component structures and functions of living and non-living entities
C46 Lead multi-age groups in the examination of and planned resolution for scientific issues
C47 Recognize and choose members of research teams based upon the merit of their ideas and skills
C48 Construct a portfolio of products, documentation, and self-evaluations of his/her own abilities, skills, and experiences
C49 Synthesize scientific information from a variety of sources
C50 Evaluate and prioritize scientific issues based upon risk-benefit analyses
C51 Refining scientific skills from a variety of experiences

Subunit: Applications for Science Learning
Competencies:

A1	Answer student-determined questions by designing databases and drawing inferences from the analyses of the information in these data bases
A2	Make personal behavior decisions by interpreting information that has a scientific basis
A3	Propose courses of action that will validate and demonstrate personal understandings of scientific principles
A4	Guide other learners in their understanding of the interactions of technologies and society at various periods in time
A5	Promote and carry out practices that contribute to a sustainable environment
A6	Study and propose improvements in public services and systems in their community
A7	Choose consumer materials utilizing personal and environmental risk and benefit information
A8	Make inferences and draw conclusions using databases, spreadsheets, and other technologies
A9	Do simple trouble-shooting on common electrical and mechanical s ystems, identifying and eliminating possible causes of malfunctions
A10	Construct devices that perform simple, repetitive actions
A11	Investigate the functionality of various geometric shapes in the natural world and the designed world (e.g., translations from spherical to plane representations cause distortions, triangular shapes contribute to rigidity and stability in structures, round shapes minimize boundary for a given capacity)
A12	Make decisions regarding personal and public health
A13	Evaluate the social and ecological risks and benefits resulting from the use of various consumer products
A14	Analyze the contributions of advances in technology through history to his/her everyday life
A15	Identify and reduce risks and threats to a sustainable environment
A16	Extend the limits of human capabilities using technological enhancements
A17	Use and recognize various propaganda techniques
A18	Solve unique problems using the results of systematic analyses
A19	Choose everyday consumer products that utilize recent innovation and pass appropriate performance criteria
A20	Refine personal career interests through investigations of the diversity of manufacturing, research, service, and invention processes

Subunit: Applications for Science Learning (continued)
Competencies:

A21 Predict and investigate the working of toys and tools while controlling and manipulating variables (e.g., friction, gravity, forces)

A22 Write, follow, modify, and extend instructions (e.g., equations, algorithms, formulas, flow diagrams, illustrations)

A23 Create products, make inferences, and draw conclusions using databases, spreadsheets, and other technologies

A24 Predict various scenarios and propose solutions to community issues using scientific information (e.g., actuarial tables, census data, topographic maps, incidence data, climatic data)

A25 Use scientific evidence to consider options and formulate positions about the health and safety of others and him/herself

A26 Search for, use, create, and store objects and information using various strategies and methods of organization and access

A27 Research and write environmental impact statements of his/her own design

A28 Compare school-based science perspectives with those gained through cutting-edge technological applications

A29 Design management plans for natural and human-altered environments (e.g., woodlots, patios, lots, lawns, farmlands, forests)

A30 Refine personal career interests

A31 Promote public awareness of the interaction of technology with social i issues

A32 Advocate and propose courses of action for local and global scientific issues using global networks

A33 Use appropriate technologies to prepare and present the findings of investigations incorporating tables, graphs, diagrams, and text

A34 Make informed consumer choices by evaluating and prioritizing information, evidence, and strategies

A35 Develop an informed point-of-view that allows for validation or refutation of the scientific statements and claims of advocated before pursuing courses of action (e.g., contributing support, signing petitions, casting votes)

A36 Differentiate between observations and inferences in the exploration of evidence related to personal, scientific, and community issues

A37 Develop and write environmental impact and safety and hygiene management plans

A38 Use technology to collect, analyze, and communicate information (e.g., electronic networks, desktop publishing, remote sensing, graphing calculators, satellite telemetry, and others)

A39 Design, construct, and market inventions

Unit: Technology Literacy

NOTE: Over 500 Ohio business, industry, and labor representatives examined, altered, and then verified the content for this unit during the TCP Process. The original content was extracted from the Report of the Task Force on Technology Competence—Learner Goals for All Minnesotans, published by the Minnesota State Council on Vocational Technical Education. The Technology Literacy unit forms a critical link between all teachers and stresses the importance of technological impact on teaching and learning. [See "The TCP Process" for more information.]

Competencies:

T1 Demonstrate a systems view of technology based on the interdependence of social, political, economic, and ecological systems

T2 Assess the career, family, and personal development implications of technological change

T3 Demonstrate continuous learning via technology

T4 Demonstrate global appreciation for technology's potential effects on cultures, geographic areas, and the environment

T5 Apply historical perspective on technology to the development and use of new technologies

T6 Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems

T7 Apply legal principles and ethical conduct to the use of technology

T8 Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems

T9 Analyze the potential of alternative technological systems to solve problems and/or to extend human capabilities

T10 Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

T11 Assess risks and benefits of technological developments from an ecological, economic, social, and political perspective

T12 Value human diversity as part of a team in suggesting, designing, and testing solutions to technological problems

Unit: Employability Skills

Competency: Develop a career plan

Competency Builders:

Identify current interests and aptitudes
Identify common barriers to employment
Describe strategies to overcome employment barriers
Locate resources for finding employment
Research job trends
Identify career options
Identify advantages and disadvantages of career options (in addition to other than monetary)
Identify job requirements
Investigate education/training opportunities
Evaluate personal strengths and weaknesses

Competency: Prepare for employment

Competency Builders:

Identify traditional and non-traditional employment sources
Identify present and future employment opportunities (by geographic location)
Research job opportunities, including non-traditional careers
Compare salary ranges and benefit packages
Compile occupational profile
Identify rights and responsibilities of equal employment opportunity laws
Design resume and cover letter
Target resume
Secure references
Investigate generic and specific employment tests (e.g., civil service exam; drug screening)
Use follow-up techniques to enhance employment potential
Demonstrate legible written communication skills using correct grammar, spelling, punctuation, and concise wording
Describe methods for handling illegal questions on job application forms and during interviews
Write letter of application
Research prospective employer and services performed
Explain critical importance of personal appearance, hygiene, and demeanor
Interpret job description
Demonstrate appropriate interview question and answer techniques
Demonstrate methods for handling difficult interview questions
Evaluate job offers
Write letter of acceptance
Write letter of declination
Demonstrate good listening skills
Ask for the job tactfully
Participate in extracurricular activities (e.g., student government, community projects,)

Competency: Evaluate the importance of self-esteem as an employability skill

Competency Builders:

Identify factors that affect self-esteem
Compare effects of low self-esteem and high self-esteem
Identify strategies to promote positive self-esteem

Competency: Demonstrate job retention skills

Competency Builders:

Identify employer expectations regarding job performance, work habits, attitudes, personal appearance, and hygiene
Exhibit appropriate work habits and attitude
Demonstrate ability to set priorities
Identify behaviors to establish successful working relationships
Identify alternatives for dealing with harassment, bias, and discrimination based on race, color, national origin, sex, religion, handicap, or age
Identify opportunities for advancement
List reasons for termination
List consequences of being absent frequently from job
List consequences of frequently arriving late for work
Demonstrate interpersonal relations skills (i.e., verbal and written)
Demonstrate negotiation skills
Demonstrate teamwork
Follow chain-of-command
Exhibit appropriate job dedication

Competency: Demonstrate knowledge of work ethic

Competency Builders:

Define work ethic
Identify factors that influence work ethic
Differentiate law and ethics
Describe how personal values are reflected in work ethic
Describe how interactions in the workplace affect personal work ethic
Describe how life changes affect personal work ethic

Competency: Exhibit appropriate work ethic

Competency Builders:

Use time-management techniques
Avoid personal activity during work hours
Attend work as scheduled
Adhere to company and/or governmental policies, procedures, rules, and regulations
Exercise confidentiality
Demonstrate appropriate human relations skills
Adhere to rules of conduct
Accept constructive criticism
Offer constructive criticism
Take pride in work
Resolve conflict
Manage stress
Avoid sexual connotations and harassment
Adjust to changes in the workplace
Demonstrate punctuality
Assume responsibility for personal decisions and actions
Take responsibility for assignments
Follow chain-of-command

Competency: Apply decision-making techniques

Competency Builders:

Identify decision to be made
Identify ownership of decision to be made
Identify possible alternatives and their consequences
Make decisions based on facts, legality, ethics, goals, and/or culture
Apply time factor(s)
Present decision to be implemented
Evaluate decision made
Take responsibility for decision

Competency: Apply problem-solving techniques

Competency Builders:

Identify problem
Select appropriate problem solving tools/techniques
Identify root problem cause(s)
Track root problem cause(s)
Identify possible solutions and their consequences (e.g., long term, short term, crisis)
Use resources to explore possible solutions to problem
Contrast advantages and disadvantages of each solution
Identify appropriate action
Evaluate results
Identify post-preventive action

Competency: Exhibit characteristics for job advancement

Competency Builders:

Display positive attitude
Demonstrate knowledge of position
Perform quality work
Adapt to changing situations and technology
Demonstrate capability/responsibility for different positions
Identify characteristics of effective leaders
Identify opportunities for leadership in work place/community
Demonstrate initiative to affect change in workplace
Participate in continuing education/training program
Responds appropriately to criticism from employer, supervisor, or other employees
Exhibit awareness of corporate culture
Prepare for job setbacks
Exhibit continual growth based on performance evaluation
Set realistic goals

Unit: Professionalism

Competency: Project professional image

Competency Builders:

Define professionalism
Exhibit professional appearance
Exhibit professional manners
Project professional attitude
Identify individuals' vital role in organization
Exhibit proper etiquette in professionally-related situations

Competency: Achieve individual and professional goals

Competency Builders:

Set flexible, realistic, and measurable goals
Identify potential barriers to achieving goals
Identify strategies for addressing barriers to goal achievement
Breakdown long-term goals into short-term goals
Prioritize goals
Commit to goals
Adjust goals
Obtain support for goals
Reward goal achievement

Competency: Manage personal finances

Competency Builders:

Explain need for personal management records
Balance checkbook
Identify tax obligations
Analyze how credit affects financial security
Compare types and methods of investments
Compare types and methods of borrowing
Compare types and methods of insurance
Compare types of retirement options/plans
Identify discriminatory vs. non-discriminatory expenditures

Competency: Support community well-being

Competency Builders:

Identify environmental, educational, and social issues
Participate in social and/or community activities

Competency: Achieve organizational goals

Competency Builders:

Evaluate personal goals in relation to organizational goals
Monitor progress by evaluating feedback
List responsibilities in relation to organization goals
Accomplish assigned tasks
Exercise responsibility in relation to organizational goals
Set appropriate personal performance standards
Communicate goals with supervisor and peers
Demonstrate knowledge of products and services
Promote organizational image and mission

Competency: Demonstrate positive relations in the workplace

Competency Builders:

Identify personality types of self and other
Identify various management styles
Support employer expectations
Support employer decisions
Accept constructive criticism
Give constructive feedback
Adapt to changes in workplace
List factors to consider before resigning
Write letter of resignation

Competency: Manage stressful situations

Competency Builders:

Accept stress as part of daily life
Identify personal and professional factors contributing to stress
Describe physical and emotional responses to stress
Evaluate positive and negative effects of stress on productivity
Identify strategies for reducing stress
Implement strategies to manage stress
Create strategies for developing and maintaining support systems

Competency: Analyze effects of family on work and work on family

Competency Builders:

Identify how family values, goals, and priorities are reflected in work place
Identify responsibilities and rewards associated with paid and non-paid work
Identify responsibilities and rewards associated with families
Explain how family responsibilities can conflict with work
Explain how work can conflict with family responsibilities
Explain how work-related stress can affect families
Explain how family-related stress can affect work
Identify family support systems and resources
Identify work-related support systems and resources
Communicate with family regarding work

Competency: Apply lifelong learning skills

Competency Builders:

Define lifelong learning
Identify factors that cause need for lifelong learning
Analyze effects of change
Identify reasons why goals change
Describe importance of flexibility and adaptability
Evaluate need for continuing education/training

Competency: Manage professional development

Competency Builders:

Identify career opportunities
Modify career plan
Participate in continuing education/training opportunities
Document continuing education/training
Read profession-related manuals, technical journals, and periodicals
Attend meetings, workshops, seminars, conferences, and demonstrations
Participate in professional organizations
Build personal/professional mentor relationship
Build personal/professional support system
Build professional network
Strengthen communication skills
Strengthen leadership skills
Strengthen management skills

Unit: Teamwork

Competency: Demonstrate knowledge of teamwork

Competency Builders:

Define empowerment
Differentiate work groups and teams
Identify conditions essential to teamwork (e.g., brainstorming)
Explain influence of culture (e.g., corporate, community) on teamwork
Identify appropriate situations for using teams
Define team structures (e.g., cross functional, quality improvement, task force, quality circles)
Identify team building concepts
Describe characteristics and dynamics of teams
Identify characteristics of effective team leaders and members
Identify responsibilities of a valuable team member
Identify methods of involving each member of a team
Explain how individuals from various backgrounds contribute to work-related situations (e.g., technical training, cultural heritage)
Explain the purpose of facilitators
Define consensus
Define reward/recognition system

Competency: Demonstrate teamwork

Competency Builders:

Identify purpose of team and intended goal (include time frames)
Structure team around purpose
Define responsibilities of team members
Contribute to efficiency and success of team
Work toward individual and team milestones
Analyze results of team project
Facilitate a team meeting
Assist team member(s) with problem
Monitor time frame
Stress continuous improvement
Accept failure as part of learning

Competency: Use teamwork to solve problems

Competency Builders:

Identify appropriate situations for using teams
Use problem-solving process in a team setting
Identify quality management processes/techniques
Identify quality assurance processes/techniques
Prepare presentation

Competency: Conduct team meetings

Competency Builders:

Plan agenda
Schedule meeting and location
Invite appropriate personnel
Solicit outside speakers as needed
Assign someone to take minutes
Facilitate introductions
Invite questions and comments and group participation
Focus team on agenda items
Assign appropriate action, time frame and accountability to tasks
Monitor time
Close meeting on time
Publish minutes in timely manner
Set ground rules
Avoid placing individual agendas above the group's agenda

Unit: Quality Assurance

Competency: Demonstrate knowledge of quality assurance

Competency Builders:

Explain the historical evolution of quality assurance (e.g., Deming, ISO 9000)
Explain changes brought about by quality leaders in the world
Explain the ISO 9000 process
Define quality terms
Define quality functions
Identify features of quality planning
Describe control devices used in functional areas (e.g., SPC, equipment)
Explain the relationship among organizational structures, policies, procedures, and quality assurance
Explain importance of internal and external customers
Identify internal and external customers
Describe successful efforts by industry to improve quality and/or reduce costs
Differentiate prevention and detection
Differentiate variable and attribute data
Identify types of coontrol charts
Explain how statistical techniques are tools used to control quality (e.g., SPC, DOE, CR)

Competency: Demonstrate knowledge of quality cost implications

Competency Builders:

Identify cost/quality objectives
Classify costs (i.e., direct and indirect, fixed and variable, methods and standards)
Classify quality costs (i.e., prevention, evaluation, pre-delivery failure, post-delivery failure)
Define produce liability
Interpret quality cost reports
Explain consumerism and liability prevention
Define safety terms of product
Identify safety responsibility within organization
Define contracts and torts
Differentiate express and implied warranty
Differentiate warranty and product liability
Explain how warranties are part of contract law
List questions that would need answering in liability claim

Competency: Demonstrate knowledge of engineering a quality product

Competency Builders:

Associate customer satisfaction with product characteristics (e.g., usefulness, price, operation, life, reliability, safety, cost of operation)
Define manufacturability
Identify steps in product design (e.g., brainstorming, thumbnail sketches, rendering)
Define reliability factors (e.g., cost, human, producibility)
Identify ways reliability is achieved (e.g., maintainability, good design, design simplification, design redundancy)
Explain the relationship of maintainability to reliability
Define failure
Explain the role of testing and reliability
Define value engineering
Define quality objectives
Identify cost components as they relate to quality objectives
Classify quality costs (i.e. preventive, evaluation, pre-delivery failures, post delivery failures)
Describe predictive maintenance

Competency: Explain importance of interdepartmental relationships to quality assurance

Competency Builders:

Explain need for everyone's commitment in assuring quality
Explain phrase "Everyone is a customer/supplier"
Define quality improvement team models
Explain the importance of top management's support of quality
Explain project selection
Explain project implementation
Explain project evaluation
Explain continuing improvement
Describe future trend of experiment design
Describe future trend of predictive maintenance

Competency: Manipulate quality cost data

Competency Builders:

Develop quality cost data
Translate cost reports
Graph quality cost data (e.g., pareto)

Competency: Manipulate cost control data

Competency Builders:

Develop cost control data
Analyze cost control reports
Provide cost control data
Provide advice on "Make or Buy" decisions (including economical lot size decisions)

Competency: Demonstrate knowledge of basic statistics

Competency Builders:

Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Define nominal, ordinal, interval, and ratio data
Define mean, median, and mode
Explain significance of standard deviation
Explain normal distribution

Competency: Demonstrate knowledge of scattergrams

Competency Builders:

Construct scattergram
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance between one and five percent
Explain regression analysis

Competency: Demonstrate knowledge of probability theory

Competency Builders:

Define classical probability
Define empirical probability
Calculate probability for outcomes

Competency: Demonstrate knowledge of precontrol

Competency Builders:

Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green, yellow and red conditions

Competency: Demonstrate knowledge of process capability

Competency Builders:

Use X, R, USL, and LSL to determine process capability (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

Competency: Use quality control charts

Competency Builders:

Identify operational definitions for attribute criteria
Interpret histogram
Interpret scattergrams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

Competency: Interpret $\bar{X}$ and R charts

Competency Builders:

Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Define an "in-control" process
Explain significance of an out-of-control point on $\bar{X}$ or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

Competency: Construct $\bar{X}$ and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute $\bar{X}$ (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in $\bar{X}$ and R on chart
Construct control chart with $\bar{\bar{X}}$ (grand average) and R (average range) calculated
Calculate upper and lower control limits for $\bar{X}$-chart
Calculate upper and lower control limits for R-chart

Competency: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})
Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)
Identify major steps in conducting a study
Define "report" for a study (e.g., goal, objective, study conduct, results, conclusions, discussions)
Integrate results into the total system

Competency: Demonstrate knowledge of JIT

Competency Builders:

Define just-in-time concept (JIT)
Describe various production methodologies (e.g., standard cycle times, routings, standard quantities, multiple-machine tending)
Describe types of inventory control (e.g., Kanban)
Describe importance of flexibility
Differentiate product layout, process layout, fixed position layout, and cellular layout
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages/disadvantages of layout and patterns
Explain importance of product protection, identification and storage
List methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Apply JIT

Comptency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of inspection

Competency Builders:

Explain purpose of inspection
Describe scope of inspection
Explain purpose of incoming, ongoing, and final inspections
Explain early detection inspection
Explain how statistical process control (SPC) aids inspection
Define types of nonconformance
Define degrees of nonconformance
Define corrective action
Describe when to 100% inspect
Describe when to sample inspect
Describe methods of testing for material properties (e.g., harness, strength, chemical makeup, flaws, errors in tooling or setup)
Define rework, salvage, and scrap
Describe ethical decisions an inspector may make
Identify purposes of computer-automated inspection
Explain advantages and limitations of automated inspection
Explain disposition of non-conforming material
Explain basic foolproofing concept to build inspection into process (i.e., poka-yoke)
Use checksheets to organize and record inspection results

Competency: Inspect machinery, materials, and products

Competency Builders:

Identify critical material characteristics from specification(s) or drawing(s)
Perform capability studies for machinery and materials acceptance
Identify appropriate acceptance sampling plan
Conduct incoming materials inspection using sampling plan criteria
Identify critical in-process characteristics from specification(s) or drawing(s)
Demonstrate basic metrology skills
Conduct in-process inspection
Identify appropriate inspection reports and follow-up
Gauge R and R (reproducibility and repeatability)
Apply geometric tolerancing
Explain C = O (zero) acceptance plan
Interpret instructions in a control plan

Competency: Demonstrate knowledge of nondestructive testing

Competency Builders:

Describe purpose of nondestructive testing
Identify anomalies
Define defects and discontinuities
Identify factors contributing to defects and discontinuities
Describe ultrasonic testing
Describe advantages and limitations of ultrasonic testing
Describe industrial radiography
Compare use of wet and dry particles in magnetic particle inspection
Explain advantages and limitations of penetrant inspection
Describe microwave testing
Describe holographic inspection
Explain choice of most suitable nondestructive test method
Describe eddy-current testing

Unit: Technical Recording and Reporting

Competency: Demonstrate proficiency in technical recording

Competency Builders:

Describe various documentation procedures
Interpret specifications or drawings
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Identify parameters
Record accurate, truthful data
Maintain test logs
Compile cumulative reference notebook/record
Measure appropriate parameters
Draft preventive maintenance and calibration procedures

Competency: Demonstrate proficiency in technical reporting

Competency Builders:

Use data books and cross reference/technical manuals
Compose technical memoranda
Identify type of report or format needed
Use appropriate format
Compile relevant data
Design charts and graphs
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports
Write reports
Present reports

Unit: Computer Literacy

Competency: Describe personal computer operations

Competency Builders:

Explain how data is stored in main computer memory
Explain how computer system executes program instruction
Explain computer storage capacity
Explain how data is represented
Describe data storage techniques
Identify types of memory

Competency: Explain information processing cycle

Competency Builders:

Define operating systems (e.g., DOS, OS/2, UNIX, MAC)
Describe computer languages and their use
Describe computer languages and their use
Describe computer languages and their use
Describe difference between data files and program files
Explain PC layout
Explain PC network layout
Explain mini/mainframe network layout
Differentiate hardware and software
Differentiate open from proprietary architecture

Competency: Operate computer hardware

Competency Builders:

Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
Identify hardware and its use
Use hardware (e.g., mouse, diskettes, drive, modems, touch screen, printers, digitizers, scanners, cables, protection devices)
Keyboard efficiently
Demonstrate basic care of hardware
Explain need for and application of security levels/procedures
Perform basic hardware troubleshooting
Explain hardware addressing techniques

Competency: Use software

Competency Builders:

Define software types and functions
Describe basic disk operations and care
Perform functions necessary to operate software
List advantages and disadvantages of integrated and dedicated software
Operate system software
Operate diagnostic software
Demonstrate basic proficiency in spreadsheet use
Demonstrate basic proficiency in word processing
Demonstrate basic proficiency in database use
Demonstrate basic proficiency in network use
Demonstrate basic proficiency of utility (e.g., WINDOWS, GUI)
Demonstrate basic proficiency in report writing
Demonstrate system commands
Differentiate ethical use/misuse of software
Describe bulletin boards/electronic mail
Apply security levels/procedures while handling sensitive data
Explain data compression techniques
Explain use and deletion of passwords

Unit: Workplace Safety

Competency: Apply general safety precautions

Competency Builders:

Identify local, state, and federal rules and regulations
Identify personal protective wear and equipment
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Identify common sense housekeeping
Interpret hazardous materials notices on containers
Use personal protective wear and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and (e.g., pneumatic safety rules and procedures)
Apply fire safety rules and procedures
Apply hazardous wastes rules and procedures
Apply first aid
Locate (MSDS)
Perform lockout and tagout
Recycle scrap metal, chips, shavings, coolants, solvents, trash, and waste materials
Apply common sense housekeeping
Use preventive maintenance checklists

Competency: Demonstrate knowledge of safety and workplace hazards

Competency Builders:

Describe corrective procedures for unsafe conditions
Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards)
Identify safety materials/equipment (e.g., absorbant socks, oil dry)
Interpret Material Safety Data Sheets (MSDS)
Explain purpose(s) of OSHA and NIOSH
Explain purpose(s) of NEC and NFPA
Identify purpose of emergency evacuation routes, master switch and lockout locations, and safety color coding systems
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe various types of toxicity (e.g., chronic, immediate)
Identify need for reporting accidents
Explain precautions required when using toxic or flammable materials
Define confined space and related requirements
Explain how international directives relate to safety

Competency: Explain purpose of industrial pollution control systems

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "right to know" legislation
Explain purpose(s) of EPA
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Define risk factor
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions
Explain use of rest pauses
Explain need for mats and footrest for standing jobs
Explain need for appropriate working heights of chairs, stools, workbenches, equipment
Explain need for adequate lighting
Explain use of anthropometric (i.e., centering one's view of everything around man) design

Unit: Supervision

Competency: Perform supervisory functions

Competency Builders:

Define supervision
Conduct task analysis
Create organizational and/or departmental charts
Apply company policies and procedures
Maintain workplace procedures manuals
Prepare budgets
Monitor budgets
Prepare managerial reports
Analyze daily production reports
Maintain appropriate work environment
Conduct tours
Facilitate assignments
Assign work
Delegate job tasks
Monitor progress
Prepare productivity reports
Provide training for new policies
Troubleshoot workplace problems
Coordinate workplace activities
Appraise performance
Document personnel issues
Coordinate administrative duties

Competency: Coordinate training

Competency Builders:

Assess training needs
Secure training resources, materials and equipment
Train employees
Evaluate progress of trainee
Provide feedback
Solicit feedback
Receive feedback
Assess feedback

Unit: Basic Electronics

Competency: Demonstrate proficiency in electronics fundamentals

Competency Builders:

Identify electronic components and schematic symbols
Describe basic atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Use metric units to solve electronic unit problems
Identify sources of electricity
Describe principles and operations of electrochemical supplies
Describe voltage, current, resistance, power, and energy
Apply Ohm's Law
Apply Kirchoff's Laws
Apply power formulas
Explain Thevenin's Theorem
Explain Norton's Theorem
Interpret color codes and symbols to identify electrical components and values
Measure properties of circuits using test equipment
Describe electrostatic discharge (ESD) procedures

Competency: Demonstrate proficiency in DC circuits

Competency Builders:

Compute conductance of conductors and insulators
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM)
Build series, parallel, and combination circuits
Build bridge circuits
Build voltage divider circuits (loaded and unloaded)
Compute voltage divider circuits (loaded and unloaded)
Demonstrate maximum power transfer theory
Describe magnetic properties of circuits and devices
Explain physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Compute RC and RL time constants
Demonstrate use of diodes in DC circuits
Identify need for rectification
Operate power supplies for DC circuits
Analyze frequency spectrums
Construct the operation of DC circuits that demonstrate maximum power transfer theory
Use meters and oscilloscopes
Measure current, voltage, and resistance in DC circuits
Explain simple DC generator action
Explain simple DC motor action
Explain principals of solid-state switching devices
Solve algebraic problems to include exponential (prerequisite to DC) (algebraic calculation)
Explain use of DC in relation to communications
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Troubleshoot DC circuits

Competency: Demonstrate proficiency in AC circuits

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Operate inductive circuits
Describe principles and operation of transformers
Demonstrate operation of AC circuits utilizing transformers
Use maximum power transfer theorems
Use Thevenin's and Norton's theorem to analyze AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Operate differentiators and integrators to determine RC and RL time constants
Describe principles and operation of characteristics of series and parallel resonant circuits
Build series and parallel resonant circuits
Identify classes, voltage, ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe principles and operation of characteristics of frequency selective filter circuits
Calculate logarithmic to obtain gain (dB) using tables or calculator/computer
Operate frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe principles and operation of various safety grounding systems (e.g., lightning arresters, ground electrostatic discharge, fault interrupters, etc.)
Describe characteristics of inductors in series and parallel circuits
Describe characteristics of capacitance in series and parallel circuits
Compare resistive-capacitive (RC) and resistive-inductive (RL) time constants (TC)
Measure voltage, current, time, frequency (f), and phase relationships of AC sine wave signal
Describe frequency (F) and phase relationships

Competency: Demonstrate proficiency in AC circuits (CONTINUED)

Competency Builders:

Describe resonance of inductive-capacitive (LC) circuits
Calculate impedance match and maximum transfer of power
Measure current, voltage, and resistance in AC circuits
Identify 50/60 Hertz
Explain simple AC generator action
Explain simple AC motor action
Calculate power factor in AC circuits
Explain harmonics and its effects on power quality
Solve basic trigonometric problems as applicable to electronics
Calculate peak (PK), root mean square (RMS), and average values
Troubleshoot AC circuits

Unit: Fundamentals of Electronics Technology

Competency: Demonstrate proficiency in discrete solid-state devices

Competency Builders:

Describe properties of semiconductor materials
Describe operating characteristics and applications of PN junctions
Demonstrate operation of diode circuits
Troubleshoot diode circuits
Repair diode circuits
Describe operating characteristics and applications of bipolar transistors
Describe operating characteristics and applications of field effect transistors (e.g., FET + s/MOSFET + s)
Describe operating characteristics and application of special diodes/transistors
Describe operating characteristics and applications of opto-electronic devices (e.g., gate isolators, interrupt sensors, infrared sensors)
Describe operating characteristics and applications of single-stage amplifiers
Demonstrate the operation of the single-stage amplifiers
Troubleshoot single-stage amplifiers
Repair single-stage amplifiers
Demonstrate the operation of thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Troubleshoot thyristor circuitry (SCR, TRIAC, DIAC, etc.)
Operate analog and digital equipment for solid-state devices
Operate power supplies for solid-state devices
Operate oscilloscopes for solid-state devices
Operate function generators for solid-state devices
Operate curve tracers
Operate transistor testers

Competency: Demonstrate proficiency in analog circuits

Competency Builders:

Operate measuring instruments for analog circuits
Describe operating characteristics and applications of linear integrated circuits
Describe operating characteristics and applications of power supplies and filters
Describe operating characteristics and applications of operational amplifier circuits
Demonstrate the operation of operational amplifier circuits
Describe the operating characteristics and applications of regulated and switching power supply circuits
Demonstrate the operation of regulated power supply circuits
Describe operating characteristics and applications of active filters
Demonstrate the operation of active filter circuits
Describe operating characteristics and applications of sinusoidal and non-sinusoidal oscillator circuits
Demonstrate the operation of oscillator circuits
Describe the operating characteristics and applications of motor phase-shift control circuits (single-phase and multi-phase)
Describe the operating characteristics and applications of cathode ray tubes

Competency: Demonstrate proficiency in digital circuits

Competency Builders:

Operate logic problems for digital circuits
Operate power supplies for digital circuits
Operate pulsers for digital circuits
Operate oscilloscopes for digital circuits
Describe characteristics of integrated circuit (IC) logic families
Describe the principles and operation of types of logic gates and their truth tables
Demonstrate the use of logic gates
Describe the principles and operation of combinational logic circuits
Demonstrate the operation of combinational logic circuits
Describe the principles and operation of numbering systems, codes, and arithmetic operations
Minimize logic circuits using Boolean operations
Describe the principles and operation of types of flip-flops
Demonstrate the operation of flip-flops
Describe the principles and operation of types of registers and counters
Demonstrate the operation of registers and counters
Describe the principles and operation of clock and timing circuits
Demonstrate the operation of clock and timing circuits
Describe the principles and operation of types of arithmetic-logic circuits
Demonstrate the operation of arithmetic-logic circuits
Describe the principles and operation of types of encoders and decoders
Demonstrate the operation of encoders and decoders
Describe the principles and operation of types of multiplexer and demultiplexer circuits
Demonstrate the operation of multiplexer and demultiplexer circuits
Describe the principles and operation of digital-to-analog and analog-to-digital circuits
Demonstrate the operation of digital-to-analog and analog-to-digital circuits
Describe the principles and operation of types of digital display circuits
Demonstrate the operation of digital display circuits
Describe the types of digital display devices
Demonstrate the operation of digital display devices
Describe the operating characteristics and applications of fiber optics
Demonstrate the operation of fiber optics

Competency: Demonstrate basic proficiency in microprocessors

Competency Builders:

Describe the essential components of a microprocessor and their functions
Identify the levels of computer languages
Operate oscilloscopes and logic/data analyzers
Describe the principles and operation of BUS concepts
Describe the principles and operation of types of memory circuits
Demonstrate the operation of memory circuits
Troubleshoot memory circuits
Repair memory circuits
Describe microprocessor instruction sets
Describe the principles and operation of microprocessor machine code
Demonstrate the use of microprocessor machine code
Debug microprocessor machine code
Interface various types of peripherals
Describe the use of microprocessor simulator(s)

Competency: Describe manufacturing of electronic devices and micromechanisms

Competency Builders:

List properties of electronic packaging materials
Describe manufacturing of electronic products chips; integrated circuits; printed integrated circuits
Describe joining and assembly of electronic components
Describe coating and etching processes
List principles of packaging electronic components
Describe manufacture of miniature devices
Describe testing of joints
Describe reliability of electronic product testing
Describe the advantages and disadvantages of various advanced packaging techniques (e.g., SMD, MCM)
Describe methods of fabrication

Unit: Troubleshooting and Repair

Competency: Demonstrate troubleshooting skills

Competency Builders:

Explain role of preventive maintenance
Differentiate normal and abnormal operations
Explain troubleshooting procedures
Explain logical actions taken to troubleshoot
Use proper troubleshooting aids
Demonstrate knowledge of safety rules for troubleshooting and repair procedures
Maintain troubleshooting and repair records
Interpret prints (e.g., PID, loopsheets)
Use manufacturer's manuals, schematics, and troubleshooting charts
Isolate faults, shorts, and open circuits

Competency: Apply troubleshooting techniques to DC circuits

Competency Builders:

Identify noise problems
Isolate faults in series, parallel and series parallel
Isolate faults in bridge circuits
Isolate faults in DC power supplies
Perform polarity check
Isolate faults to DC drive system
Isolate faults in voltage divider circuits
Repair faults

Competency: Apply troubleshooting techniques to AC circuits

Competency Builders:

Isolate faults in capacitive circuits
Isolate faults in inductive circuits
Isolate faults in AC circuits utilizing transformers (e.g., step up and step down)
Isolate faults in differentiator and integrator circuits
Isolate faults in RC, RL, and RLC circuits
Isolate faults in frequency selective filter circuits
Isolate faults to AC frequency drive systems
Repair faults

Competency: Apply troubleshooting techniques in discrete solid-state devices

Competency Builders:

Isolate faults in diode circuits
Isolate faults in thyristor circuitry (e.g., SCR, TRIAC, DIAC)
Isolate faults in transistor circuits
Isolate faults in operational amplifier circuits
Isolate faults in single-stage amplifiers
Isolate faults in open circuits
Repair faults

Competency: Apply troubleshooting techniques to analog circuits

Competency Builders:

Isolate faults in single and multistage amplifiers
Isolate faults in audio power amplifiers
Isolate faults in regulated and switching power supply circuits
Isolate faults in active filter circuits
Isolate faults in oscillator circuits
Isolate faults in operational amplifier circuits
Isolate faults in power supplies (loaded and unloaded) and filters
Repair faults

Competency: Apply troubleshooting techniques to digital circuits

Competency Builders:

Identify noise problems
Isolate faults in multiplexer and demultiplexer circuits
Isolate faults in digital display circuits
Isolate faults in logic gates
Isolate faults in flip-flops
Isolate faults in registers and counters
Isolate faults in clock and timing circuits
Isolate faults in arithmetic-log circuits
Isolate faults in encoders and decoders
Isolate faults in digital-display devices
Repair faults

Competency: Apply troubleshooting techniques to a microcomputer system

Competency Builders:

Isolate faults to systems boards
Isolate faults to memory circuits
Isolate faults to data storage devices
Isolate faults in power supplies
Troubleshoot I/O ports
Isolate faults in I/O interface circuitry
Use diagnostic software
Repair faults

Competency: Apply troubleshooting techniques to manufacturing systems

Competency Builders:

Identify individual process blocks of assembly line or process
Identify process block interfaces
Demonstrate steps required for efficient systems troubleshooting
Isolate system faults to process block
Isolate block faults using schematics
Isolate block faults using programmable controller indicators
Isolate block faults using volt meter
Repair block faults by replacing fault component or wiring

Unit: Industrial Electricity

Competency: Explain basic industrial electricity theory

Competency Builders:

Describe atomic structure and its relationship to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Identify potential sources of electricity
Describe differences between AC/DC
Describe effects varying degrees of electricity have on the human body

Competency: Use the National Electrical Code (NEC)

Competency Builders:

Use NEC to identify correct materials
Use NEC to identify correct methods
Use NEC to identify correct applications
Use NEC to identify correct safety procedures

Competency: Explain operation of electrical distribution systems

Competency Builders:

Follow NFPA, local, state, and national codes
Describe functions of permits and licensing requirements
Explain generation of electricity
Explain transmission of electricity
Explain end user distribution

Competency: Maintain basic electrical systems

Competency Builders:

Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs and sockets
Replace control panel components (e.g., relays, motor starters)
Replace AC motors (e.g., 3 phase, single phase)
Replace DC motors

Competency: Interpret electrical/electronic drawings

Competency Builders:

Interpret basic electric/electronic standards and symbols (e.g., NEC, IEC)
Interpret schematic drawings
Interpret cable drawings
Interpret component drawings
Interpret logic diagrams
Interpret control panel drawings
Interpret connection drawings
Interpret interconnection drawings
Interpret printed circuit board drawings
Interpret harness drawings
Interpret package drawings
Interpret mechanical/electronic production blueprints and assembly drawings

Competency: Demonstrate proficiency in direct current (DC) circuits

Competency Builders:

Describe voltage, current, resistance, power, and energy
Solve algebraic problems to include exponential (prerequisite to DC)
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters and oscilloscopes
Apply Ohm's Law
Construct parallel circuits
Construct series circuits
Construct series parallel and bridge circuits
Define voltage divider circuits (loaded and unloaded)
Construct DC circuits that demonstrate the maximum power transfer theory
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Interpret color codes and symbols to identify electrical components and values
Measure properties of a circuit using analog and digital meters and oscilloscopes
Measure conductance and resistance of conductors and insulators
Describe magnetic properties of circuits and devices
Describe the physical and electrical characteristics of capacitors and inductors
Describe RC and RL time constants
Set up power supplies for DC circuits
Operate power supplies for DC circuits
Analyze frequency spectrums
Apply Thevenin's and Norton's theorems

Competency: Demonstrate proficiency in alternating current (AC) circuits

Competency Builders:

Solve basic trigonometric problems as applicable to electricity (prerequisite to AC)
Analyze AC signals utilizing VOM, DVM, oscilloscope, frequency counter and function generator
Analyze power in AC circuits
Measure power in AC circuits
Operate capacitor and inductor analyzers for AC circuits
Analyze properties of an AC signal
Describe the principles and operation of the characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe the principles and operation of the characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Describe the principles and operation of the characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Describe the principles and operation of the principles of transformers
Demonstrate the operation of AC circuits utilizing transformers
Operate differentiators and integrators to determine RC and RL time constants
Describe the principles and operation of the characteristics of RLC circuits (series, parallel, and complex)
Demonstrate the operation of RLC circuits (series, parallel, and complex)
Describe the principles and operation of the characteristics of series and parallel resonant circuits
Operate series and parallel resonant circuits
Describe the principles and operation of the characteristics of frequency selective filter circuits
Demonstrate the operation of frequency selective filter circuits
Operate polyphase circuits
Describe basic motor theory and operation
Describe basic generator theory and operation
Operate power supplies for AC circuits
Describe the principles and operation of various power conditioning (e.g., isolation transformers, surge suppressors, uninterruptable power systems)
Describe the principles and operation of various safety grounding systems (e.g., lightning arresters, ground fault interrupters, etc.)
Apply maximum power transfer theorems
Apply Thevenin's and Norton's theorems to analyze AC networks

Unit: Electrical Test and Measurement Equipment

Competency: Demonstrate proficient use of electrical test equipment

Competency Builders:

Describe function and operation of logic probe and logic analyzer
Describe function and operation of power monitor
Describe function and operation of signal generator
Describe function and operation of spectrum analyzer
Describe function and operation of AC/DC hi-pot
Describe function and operation of time-domain reflectometer (TDR)
Describe function and operation of megger
Describe function and operation of curve tracer/analogger
Apply test equipment to DC circuits
Apply test equipment to AC circuits
Apply test equipment to solid-state devices
Apply test equipment to digital circuits
Apply test equipment to analog circuits
Apply test equipment to microprocessors

Competency: Demonstrate proficient use of electrical measurement equipment

Competency Builders:

Describe function and operation of analog volt-ohm-meter (AVOM)
Describe function and operation of digital volt-ohm-meter (DVOM)
Describe function and operation of amp probe
Describe function and operation of oscilloscopes
Describe function and operation of operation of infrared heat sensor
Apply measurement equipment to DC circuits
Apply measurement equipment to AC circuits
Apply measurement equipment to solid-state devices
Apply measurement equipment to digital circuits
Apply measurement equipment to analog circuits
Apply measurement equipment to microprocessors

Unit: Drafting Technology

Competency: Apply basic drafting skills

Competency Builders:

Use drafting equipment, measuring scales, drawing media, drafting instruments and consumable materials, blueprint machine
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Prepare multi-view drawings
Prepare multi-view sketches
Prepare orthographic views
Prepare change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Prepare single-view drawings
Prepare dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

Competency: Apply intermediate drafting skills

Competency Builders:

Describe types of blueprints and their applications
Apply isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Prepare views of drilled and tapped holes, counterbores, countersinks
Apply systems drafting techniques
Identify a bill of materials
Dimension drawings using ANSIy14.5 standards
Describe purpose of auxiliary and sectional views

Competency: Apply advanced drafting skills

Competency Builders:

Interpret reports and specifications
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols
Interpret various drawings (e.g., welding, casting, stamping, forging, civil, maps, pattern shop)

Competency: Interpret basic prints

Competency Builders:

Visualize object from drawing
Interpret orthographic projections
Interpret isometric views
Interpret sectional views
Interpret detail and assembly drawings
Interpret dimensions
Interpret tolerances

Competency: Interpret intermediate prints

Competency Builders:

Interpret screw thread specifications
Identify structural steel shapes
Interpret special symbols
Interpret electrical, pneumatic/hydraulic drawings
Interpret schematics

Competency: Interpret advanced prints

Competency Builders:

Interpret GD&T characteristic symbols
Interpret GD&T supplementary symbols

Competency: Demonstrate knowledge of basic geometric dimensioning and tolerancing

Competency Builders:

Identify geometric characteristics and symbols (i.e., flatness, straightness, roundness, cylindricity, profile of line, profile of surface, perpendicularly, angularity, parallelism, circular, runout, total indicated runout, position, concentricity, and symmetry)
Define maximum material condition
Define least material condition
Define regardless of feature size condition
Describe feature control blocks
Describe datum surfaces and targets
Define flatness (pitch)
Define straightness (yaw)
Define roundness
Define cylindrically
Define profile of line
Define profile of surface
Define perpendicularity
Define angularity
Define parallelism
Define circular runout
Define total runout
Define true position concept to determine tolerance for location of holes in mating parts

Competency: Convert dimensions and tolerances

Competency Builders:

Convert dimensions and tolerances from English units to metric units
Convert dimensions and tolerances from metric units to English units

Competency: Apply revision control process

Competency Builders:

Apply drawing balloons
Apply documentation (including project filing, back-up material, tracking process)
Apply change control block
Apply revision levels

Competency: Demonstrate dimensioning techniques

Competency Builders:

Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Dimension arcs
Dimension angles
Dimension curves
Dimension rounded-end shapes
Dimension spherical objects
Dimension cylindrical objects
Dimension cones, pyramids, and prisms
Dimension features on circular center line
Dimension theoretical point of intersection
Dimension object using rectangular coordinate system
Dimension object using polar coordinate system
Dimension object using tabular coordinate system
Dimension object using ordinate dimensioning system

Competency: Apply geometric dimensioning and tolerancing

Competency Builders:

Interpret decimal tolerance dimensions
Calculate clearance fit tolerances of mating parts
Dimension clearance fit tolerances of mating parts
Calculate interference fit tolerances of mating parts
Dimension interference fit tolerances of mating parts
Calculate tolerances to mating parts using standard fit tables
Assign tolerances to mating parts using standard fit tables
Apply positional and form tolerancing symbols
Apply symbols for true position
Apply symbols for maximum material control and regardless of feature size
Calculate effects of dimensional stack-up
Calculate transitional fit tolerances
Dimension transitional fit tolerances

Competency: Perform basic physical layouts

Competency Builders:

Use inside diameter (ID), outside diameter (OD), and hermaphrodite calipers
Layout with combination square
Layout with scriber, divider and trammel
Use surface plate
Use surface gage
Use layout fluid
Use V-blocks
Use clamps
Use angle plate
Use parallels
Use punches
Use transfer method tools
Use layout hammer
Use machinist's square
Use universal bevel protractor
Use machinist's scale

Competency: Prepare mechanical drawings

Competency Builders:

Interpret basic mechanical standards and symbols
Prepare assembly drawings
Prepare welding drawings
Prepare bearing drawings
Prepare casting drawings
Prepare forging drawings
Prepare tool drawings
Prepare molding diagrams
Prepare drawings with special processed holes
Prepare stamping drawings
Prepare numerical control drawings/instructions
Prepare installation drawings
Prepare purchase part drawings
Prepare approval drawings

Competency: Prepare advanced mechanical drawings

Competency Builders:

Resolve problems by descriptive geometry and revolutions
Use precision dimensioning to include geometric characters
Use precision measuring instruments (e.g., calipers)
Prepare fastener drawings
Prepare cam drawings
Prepare gear drawings
Prepare spring drawings
Prepare pulley and chain drive drawings

Unit: CADD Fundamentals

Competency: Demonstrate basic use of computer operating system

Competency Builders:

Create ASCII text files with a text editor
Explain rules for naming files and directories
Manage files
Create directories
Remove directories
Change directories
Copy files
Rename files
Erase files
Format diskettes
Label diskettes
Explain the syntax of operating system commands
Use wildcards in operating system commands

Competency: Operate a CADD system

Competency Builders:

Execute CADD system
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Use file conversion
Use data transfer

Competency: Select entities for action

Competency Builders:

Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type, all, etc.)

Competency: Create 2-D orthographic drawings

Competency Builders:

Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap, etc.)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror, etc.)
Edit drawing entities (e.g., offset, trim, extend, break, mirror, etc.)
Set system variables (e.g., units, scale)
Use system variables
Create layers
Name layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks

Competency: Annotate orthographic drawings

Competency Builders:

Create text styles
Edit text styles
Select text styles
Apply notes

Competency: Dimension orthographic drawings

Competency Builders:

Create dimensions
Edit text
Control dimension variables/models

Competency: Control display

Competency Builders:

Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views
Display views

Competency: Extract entity and drawing information

Competency Builders:

Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit: Equipment Installation

Competency: Explain installation procedures

Competency Builders:

Explain relocation procedures for new equipment in an existing facility
Explain the use of anchors and isolators
Explain procedures for moving and installing new equipment
Explain leveling and aligning procedures
Explain test run guidelines
Explain safety precautions for equipment installation procedures
Explain grounding procedures
Explain installation of utilities (e.g., electricity, air, water, drains)

Competency: Prepare for equipment installation

Competency Builders:

Identify equipment requirements (including safety)
Identify maintenance services needed
Identify method of moving and equipment needed
Identify measuring devices
Calculate weights
Follow manufacturer's specifications and mannuals
Identify applicable electrical, mechanical, hydraulic, and/or pneumatic principles
Read drawings/schematics
Revise drawings if applicable
Interpret prints

Competency: Install Equipment

Competency Builders:

Prepare site
Use measuring devices
Calculate weight
Follow manufacturer's specifications
Use appropriate moving equipment
Align equipment to layout specifications
Apply electrical, mechanical, hydraulic, and/or pneumatic principles

Competency: Explain rigging functions

Competency Builders:

Estimate the weight of a load
Find the center of gravity
Identify the rigging and slings used in maintenance work
Explain safety inspection procedures for rigging, ropes, and slings
Perform safety inspection procedures for rigging, ropes, and slings
Identify rope fiber types
Tie rigging knots, bends, and hitches
Identify types of wire rope
Cut wire rope assemblies and termination's
Identify cranes and hoists
Identify and explain scaffolding types
Identify safety equipment (e.g., life belts, nets, etc.)

Competency: Perform rigging functions

Competency Builders:

Perform safety inspection procedures for rigging, ropes, and slings
Tie rigging knots, bends, and hitches
Cut wire rope
Seize wire rope
Install wire rope eyes, sockets, and hooks
Splice wire rope
Erect a scaffold
Rig life belts and nets

Unit: Equipment Maintenance

Competency: Perform housekeeping

Competency Builders:

Dispose of scrap metal chips, shavings, trash and waste
Clean work area
Store hand tools, cutters, fixtures, jigs and attachments
Store grinding wheels
Follow tool crib procedures
Inspect machine guards
Replace or adjust machine guards
Report problems to supervisor

Competency: Perform recordkeeping

Competency Builders:

Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Complete work order
Complete internal requisition
Complete external requisition
Complete time cards
Complete job status reports
Complete equipment failure reports
Record preventive maintenance activities
Record repair activities
Read job orders and process sheets
Locate tooling and set up information
File reports
Prepare new/replacement equipment recommendations

Competency: Inspect machine systems

Competency Builders:

Explain planned maintenance
Explain predictive maintenance measures
Explain preventive maintenance measures (e.g., lubrication)
Log machine histories
Explain machine system(s) calibration
Inspect linkages and lever mechanisms
Inspect drive couplings
Inspect clutches
Inspect roller ball bearings
Inspect safety systems
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance services

Competency: Perform machine maintenance

Competency Builders:

Use operator's and manufacturer's manuals
Operate individual machines
Diagnose malfunctions
Apply lockout/tagout procedure
Disassemble defective section
Clean equipment
Lubricate equipment
Check equipment for wear and alignment
Repair or replace defective parts
Test machine for performance
Make minor adjustments to equipment
Prepare planned maintenance schedules
Explain breakdown maintenance

Competency: Maintain hand tools

Competency Builders:

Demonstrate use and care of measuring devices (e.g., rules, tapes, calipers, micrometers, multimeter, thermometer, and coordinate measuring system)
Demonstrate use and care of equipment used to bend and assemble rigid conduit and tubing
Demonstrate use and care of common hand tools
Demonstrate use and care of wood working tools (e.g., saws, planes, drills, hammers)
Demonstrate use and care of sheet metal tools (e.g., sheet metal gauges, hand seamers, soldering irons)
Demonstrate use and care of ropes, slings, pullers, and block and tackle
Demonstrate proper metal working bench skills (including use of vices, hacksaws, files, tapes, dies, and reamers)
Demonstrate use and care of pipe clearing equipment

Competency: Maintain portable power tools

Competency Builders:

Demonstrate use and care of light-duty and heavy-duty drills
Demonstrate use and care of electric hammers
Demonstrate use and care of pneumatic drills and hammers
Demonstrate use and care of power screwdrivers and impact wrenches
Demonstrate use and care of linear motion saws
Demonstrate use and care of circular saws
Demonstrate use and care of routers and planes
Demonstrate use and care of belt, pad and disc sanders
Demonstrate use and care of grinders and shears
Demonstrate use and care of explosive actuated tools
Demonstrate use and care of electric lifts

Competency: Maintain stationary equipment

Competency Builders:

Demonstrate use and care of mechanical presses
Demonstrate use and care of hydraulic presses
Demonstrate use and care of drill presses
Demonstrate use and care of bench grinders
Demonstrate use and care of power saws (e.g., hack, cut-off, chop, band, jig, and table)
Demonstrate use and care of band saws
Demonstrate use and care of pipe threaders
Demonstrate use and care of metal brakes
Demonstrate use and care of power shears

Unit: Mechanical Power Transmission

Competency: Demonstrate knowledge of basic mechanics

Competency Builders:

Explain working forces of torque, tension, and compression
Explain the laws of motion
Explain how to calculate work in several ways
Explain the function of simple machines including levers, inclined plane, wedge wheel and axle, pulley and screw, gears
Explain the types of power and the method of producing power
Explain the laws of friction
Explain mechanical efficiency
Apply basic knowledge of physics
Apply basic knowledge of stress, strain, and fatigue
Calculate speed changes

Competency: Describe mechanical power transmission systems

Competency Builders:

Describe the principles and operation of compound and reverted gear trains
Describe the principles and operation of internal and planetary gear trains
Describe the principles and operation of helical and bevel gear trains
Describe the principles and operation of rack and pinion, worm and wheel, and block and screw mechanisms
Describe the principles and operation of counter rotating mechanisms and differentials
Describe the principles and operation of spring mechanisms, pulley blocks and differentials
Describe the principles and operation of chain, belt and disc drives and universal joints
Describe the principles and operation of clutch and coupling mechanisms
Describe the principles and operation of braking mechanisms
Describe the necessity for proper alignment and fit of mechanical devices
Describe the necessity for proper balance of system components
Describe proper component matching (e.g., sheave sets, gear sets)

Competency: Use bearings

Competency Builders:

Define bearing
Identify types of bearings and their applications
Identify installation method
Install bearings
Maintain bearings (e.g., lubrication)
Remove bearings
Identify bearing failure modes

Competency: Use seals

Competency Builders:

Define seal
Identify types of seals and their applications
Identify installation method
Install seals
Maintain seals
Remove seals
Identify failure modes

Competency: Use gears

Competency Builders:

Define gears
Identify types of gears, their materials, and their applications
Identify installation method
Install gears
Maintain gears (e.g., lubrication)
Remove gears
Identify failure modes

Competency: Use sheaves

Competency Builders:

Define sheaves
Identify types, tolerances, and materials of sheaves and their applications
Identify installation method
Install sheaves
Maintain sheaves
Remove sheaves
Identify failure modes

Competency: Use belts and pulleys

Competency Builders:

Define belts and pulleys
Identify types of belts and pulleys and their applications
Identify installation method
Install belts and pulleys
Maintain belts and pulleys
Remove belts and pulleys
Identify failure modes

Competency: Use sprockets and chains

Competency Builders:

Define sprockets and chains
Identify types of sprockets and chains and their applications
Identify installation method
Install sprockets and chains
Maintain sprockets and chains
Remove sprockets and chains
Identify failure modes

Competency: Use cams and levers

Competency Builders:

Define cams and levers
Identify types of cams and levers and their applications
Identify installation method
Install cams and levers
Maintain cams and levers
Remove cams and levers
Identify failure modes

Competency: Use clutches and brakes

Competency Builders:

Define clutches and brakes
Identify types of clutches and brakes and their applications
Identify installation
Install clutches and brakes
Maintain clutches and brakes
Remove clutches and brakes
Identify failure modes

Competency: Install drive components

Competency Builders:

Identify types of couplings and their applications
Install solid coupling
Install jaw coupling
Install molded rubber coupling
Install chain type coupling
Install a clutch
Install brakes
Align bearings, bushing, and cams
Install V-belts and adjust tensions
Install a V-belt and manually adjustable sheaves
Adjust a V-belt and manually adjustable sheaves
Install a V-belt with spring loaded adjustable sheaves
Explain the purposes and advantages of a chain drive system
Explain the function of speed reducers
Explain the function of gears and variable speed reducers
Install shafts
Align shafts
Mount drive sprockets and chains
Mount sheaves and pulleys
Mount gears on open gear drives
Align gears on open gear drives
Install a mechanical clutch system
Install adjustable speed drives
Troubleshoot adjustable speed drives
Explain the operation of fluid couplings
Install fluid couplings
Install torque converters
Perform preventive maintenance on drive components
Inspect completed work
Describe types of fit and tolerances
Explain importance of balance

Competency: Describe the operation of mechanisms, linkages and levers

Competency Builders:

Describe class one, two, three, and compound levers
Describe the principles and operation of rocker arm and bell crank linkages and combined mechanisms
Describe the principles and operation of four-bar mechanisms (crank, rocker, and double rocker)
Describe the principles and operation of drag link and intermediate mechanisms
Describe the principles and operation of four-bar variations
Describe the principles and operation of cam mechanisms
Describe the principles and operation of pivoted follower mechanisms
Describe the principles and operation of toggle, quick return, and ratchet mechanisms
Describe the principles and operation of geneva mechanisms

Competency: Apply knowledge of lubricants

Competency Builders:

Explain the function of lubricants
Explain the properties of oil lubricants and factors determining the selection of lubricants
Identify types and functions of lubricant additives
Describe types of circulating oils and their purposes
Describe lubricating systems, including the charts and methods used
Demonstrate proper grease application
Demonstrate proper lubricant storage and handling
Lubricate a piece of industrial equipment
Identify specified lubricant or equivalent
Explain lubricant recovery and disposal
Explain use of oil analysis reports

Unit: Electromechanical Technology

Competency: Interpret electromechanical drawings

Competency Builders:

Identify types of drawings and their applications
Transfer measurements
Explain the use of auxiliary views, revolutions, and sectional views
Describe dimensioning practices and techniques on drawings
Interpret mechanical/electronic production and assembly drawings

Competency: Describe the operation of electronic sensors and transducers

Competency Builders:

Explain temperature transducers operation
Explain stress and strain transducers operation
Explain magnetic transducers operation
Explain liquid and fluid flow transducers operation
Explain fiber optic system operation

Competency: Demonstrate proficiency in transducers (sensors) and instrumentation

Competency Builders:

Describe characteristics associated with transducers and instrumentation
Describe the principles and operations of various types of transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Demonstrate the use of various transducers (e.g., thermal, shock/vibration, acceleration, positional, pressure, flow, optical, gas and humidity)
Troubleshoot transducers
Differentiate among thermocouple types
Interpret specifications of temperature sensors (e.g., thermocouples, thermistors, resistance temperature devices)
Interpret specification of pressure sensors (e.g., strain gage, piezzo electric/piezzo resistive) to electrical circuits
Interpret specifications of flow sensors (e.g., orifice flow meter, turbine meter, mass flow meters)
Interpret specifications of speed or position sensor (e.g., tachometer, resolver encoder, linear voltage differential transformer (LVDT)
Interpret specifications of controllers, indicators, and recorders (e.g., process controllers, programmable logic controllers with interfaces, R-chart recorders, dataloggers/indicators)
Interpret specifications of final control elements (i.e., silicon controlled rectifiers (SCR), power controllers, motor drives, actuators/robots)
Describe application circuits
Calculate specification of proximity sensors
Calculate specifications of infrared and photo-sensors
Explain use of proximity sensors
Explain use of photo electric sensors
Explain use of mechanically activated switches
Troubleshoot switch failure
Describe transducer control and measurement circuits
Demonstrate the use of control and measurement circuits
Troubleshoot control and measurement circuits

Competency: Demonstrate proficiency in power distribution systems

Competency Builders:

Describe power distribution systems
Describe poly-phase distribution systems
Describe single-phase distribution systems
Describe DC distribution systems
Describe delta distribution systems
Describe wye distribution systems
Describe medium-voltage distribution systems (less than 600v)
Troubleshoot poly-phase distribution systems
Troubleshoot single-phase distribution systems
Troubleshoot DC distribution systems
Troubleshoot delta distribution systems
Troubleshoot wye distribution systems
Troubleshoot medium-voltage distribution systems

Competency: Demonstrate proficiency in power distribution equipment

Competency Builders:

Describe power transformers
Describe power capacitors
Describe power oil switches and cutouts
Describe application of NEMA or IEC controls
Describe different types of enclosures for controls
Describe current transformers
Describe potential transformers
Describe medium-voltage circuits breakers and fuses
Use medium-voltage safety equipment
Troubleshoot power transformers
Troubleshoot power capacitors
Troubleshoot power oil switches and cutouts
Troubleshoot current transformers
Troubleshoot potential transformers
Troubleshoot medium-voltage circuit breakers and fuses

Competency: Demonstrate proficiency in motors and motor control

Competency Builders:

Test solid state components with ohmmeter
Test solid state DC motor control circuits
Test solid state AC motor control circuits
Calibrate or recalibrate equipment
Identify SCR and TRIAC AC control circuits
Explain how load is connected to 3-phase wye configured AC generator
Identify wye connected and delta connected 3-phase motors
Explain revolving fields in AC motors
Describe operation of common AC motors
Describe operation of variable frequency AC drives
Define advantages and disadvantages of common DC motors
Explain how motor load affects speed regulation
Describe operation of stepper motors
Describe speed control of various types of motor drives using sensors
Identify defective motors
Describe regenerative dynamic breaking
Describe operation of various feedback loops

Competency: Apply quality control techniques

Competency Builders:

Perform preventive maintenance
Perform predictive maintenance
Apply statistical process control (SPC)
Recalibrate equipment
Apply problem-solving tools and techniques

Competency: Apply electromechanical maintenance management practices

Competency Builders:

Keep maintenance records
Complete work order
Complete internal requisition
Complete external requisition
Explain planned maintenance
Explain breakdown maintenance
Explain predictive maintenance
Establish maintenance schedules
Explain reasons for keeping maintenance records
Explain reasons for keeping cost records
Analyze system failure
Make minor adjustments/repairs
Coordinate maintenance service
Make new/replacement equipment recommendations
Interpret bill of materials for allocation, stocking, and raw material information
Analyze use of bill of materials for workplace decision making

Unit: Precision Machining

Competency: Perform prerequisite machining skills

Competency Builders:

Demonstrate maintenance of immediate work area, machinery, tools and gages
Demonstrate proficiency in interpreting prints/drawings
Demonstrate proficiency in planning work sequence/set up
Follow safety rules and regulations for each machine

Competency: Analyze machine shop jobs

Competency Builders:

Identify sequence of work on specified project(s)
Identify tolerances and finishes on specified project(s)
Identify variables that effect job efficiency (e.g., speeds, feeds)
Use Machinery Handbook
Identify causes of workpiece defects

Competency: Achieve machine shop job standards

Competency Builders:

Write machine shop job procedure
Complete machine shop job status report(s)
Analyze machine shop job evaluation data

Competency: Perform bench operations

Competency Builders:

Use measuring instruments and hand tools
Deburr workpiece
Lay out workpiece
Drill hole
Hand tap hole
Cut threads with die
Apply basic metallurgy knowledge

Competency: Operate metal cutting saw

Competency Builders:

Identify types and uses
Identify proper cutting fluids
Transfer dimensions from blueprint
Clean metal cutting saw
Lubricate metal cutting saw
Install guides
Adjust guides
Select proper blades
Weld saw blade
Install saw blade
Select speeds and feeds
Cut metal
Deburr workpiece
Apply basic metallurgy knowledge

Competency: Operate drill press

Competency Builders:

Clean drill press
Lubricate drill press
Identify proper cutting fluid
Mount part
Select proper bit, speed, and feed
Demonstrate proper bit sharpening techniques
Drill part
Countersink
Tap hole
Apply basic metallurgy knowledge

Competency: Operate tool and cutter grinding machine

Competency Builders:

Identify parts of machine
Identify proper cutting fluids
Identify causes of workpiece defects
Select proper wheels and work holding devices (e.g., superabrasives)
Perform truing operations
Perform dressing operations
Perform forming operations
Select proper speeds and feeds
Sharpen end mill
Sharpen horizontal milling cutter
Sharpen drills and countersinks
Apply basic metallurgy knowledge

Competency: Operate pedestal grinder

Competency Builders:

Clean pedestal grinder
Lubricate pedestal grinder
Identify proper wheel
Identify proper coolant
Check wheel for defects
Mount wheel
Position guard and rest
Dress wheel
Sharpen drill bit
Apply basic metallurgy knowledge

Competency: Operate lathe

Competency Builders:

Clean and lubricate lathe
Identify proper cutting fluid
Identify proper tools and holders
Sharpen tools properly
Mount workpiece
Use dial indicator
Position guards
Select feed(s) and speed(s)
Face workpiece
Turn shaft
Turn taper
Knurl workpiece
Cut off workpiece
Deburr
Demonstrate use of a 4-jaw chuck
Center drill hole
Cut threads (inside and outside)
Turn inside bore
Demonstrate use of steady rest
Demonstrate use of centers
Apply basic metallurgy knowledge

Competency: Operate milling machine

Competency Builders:

Clean milling machine
Lubricate milling machine
Identify proper cutting fluid
Select proper tool
Select proper feeds and speeds
Type of cut (e.g., climb, std.)
Mount workpiece
Mount tool
Mill surface
Mill keyway
Drill workpiece
Bore with milling machine
Mill angle
Apply basic metallurgy knowledge

Competency: Operate surface grinder

Competency Builders:

Clean surface grinder
Lubricate surface grinder
Identify proper cutting fluid
Select proper wheel
Select proper speeds and feeds
Check wheel for defects
Mount wheel
Position guard
Dress wheel
Identify proper mounting techniques
Mount workpiece
Set surface grinder
Apply basic metallurgy knowledge

Competency: Select materials for job

Competency Builders:

Interpret color codes, numbering systems, and classification systems of materials (i.e., ANSI, SAE)
Identify metals using spark test
Identify metals using variety of tests
Identify materials
Apply basic metallurgy knowledge

Competency: Perform heat treatment and testing of metals

Competency Builders:

Test hardness of metals
Perform non-destructive testing
Perform destructive testing
Harden metals to job specifications
Temper metals to job specifications
Anneal metals to job specifications
Normalize metals to job specifications
Case harden metals to job specifications

Competency: Explain nontraditional machining processes

Competency Builders:

Describe principles of chemical etching
List applications of chemical etching
List advantages/disadvantages of chemical etching
Describe principles of photochemical etching
List applications of photochemical etching
List advantages/disadvantages of photochemical etching
Describe electrical-discharge machining (EDM)
List applications of EDM
Differentiate between EDM and wire EDM
List applications for wire EDM
Describe principles of electrochemical machining
List applications of electrochemical machining
List advantages/disadvantages of electrochemical machining
Describe principles of water jet cutting
List applications of water jet cutting
Describe principles of torch cutting
List applications of torch cutting
Describe principles of laser cutting
List applications of laser cutting
List advantages/disadvantages of laser cutting
Describe shot peen
Describe media finish
Describe glass bead
Describe principles of laser welding

Competency: Perform precision layouts

Competency Builders:

Identify appropriate tools for measuring
Describe precision, accuracy, tolerance, reliability, and discrimination
Distinguish between precision and semiprecision measuring
Define standard stock dimensions and tolerances
Demonstrate knowledge of different units of measure (metric, standard, inches, etc.)
Describe common measurement errors and correction procedures
Calibrate measuring machines and devices
Demonstrate care of measuring instruments
Demonstrate use of rule
Demonstrate use of tape
Demonstrate use of pi tape
Demonstrate use of combination square
Demonstrate use of calipers
Demonstrate use of micrometers (inside and out)
Demonstrate use of dial indicators
Demonstrate use of sine bar
Demonstrate use of gauges (e.g., dial bore, dial snaps)
Demonstrate use of surface plate
Demonstrate use of protractor
Explain use of profilometer
Demonstrate use of thermometer
Demonstrate use of dividers
Demonstrate basic use of gauge blocks
Demonstrate use of threading specs
Explain use of optical comparitor
Explain use of digital instruments
Explain use of electronic gauging equipment
Explain use of data acquisition equipment
Explain operation of manual coordinate measuring machine (CMM)
Explain use and application of laser alignment/measurement

Unit: Fundamentals of Machine Anatomy

Competency: Interpret specifications for a machine

Competency Builders:

Identify power source
Identify power transmission
Identify hydraulic/pneumatic actuators
Identify materials
Identify fits/tolerances
Identify GD&T symbols
Identify safety factors
Participate in concurrent engineering
Demonstrate knowledge of print reading

Competency: Build a machine to specifications

Competency Builders:

Install hydraulic and pneumatic actuators
Troubleshoot hydraulic and pneumatic actuators
Install motors
Troubleshoot motors
Install sensors
Troubleshoot sensors
Install PLC's
Troubleshoot PLC's
Install industrial controls
Troubleshoot industrial controls
Install power distribution systems
Troubleshoot power distribution systems
Install brakes and clutches
Troubleshoot brakes and clutches
Install lubrication system
Troubleshoot lubrication system

Unit: Hydraulics and Pneumatics

Competency: Describe fluid flow concepts

Competency Builders:

Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

Competency: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

Competency: Describe system losses

Competency Builders:

Differentiate turbulent and laminar flow
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

Competency: Describe hydrostatics

Competency Builders:

Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

Competency: Calculate energy

Competency Builders:

Apply Pascal's Law
Apply Bernoulli's Principle
Apply Boyle's Law
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

Competency: Design basic hydraulic/pneumatic system

Competency Builders:

Use common symbols
Create circuit diagrams (i.e., schematics)
Diagram closed-loop hydraulic system
Diagram an air supply system

Competency: Describe component operation

Competency Builders:

Identify functions and operation of hydraulic components
Identify functions and operation of pneumatic components
Explain application(s) of different materials (e.g., plastic, copper)

Competency: Interpret hydraulic and pneumatic schematics

Competency Builders:

Identify common symbols
Sketch circuit diagrams (i.e., schematics)
Interpret circuit diagrams (i.e. schematics)
Sketch circuit analysis
Diagram an air supply system

Competency: Troubleshoot hydraulic and pneumatic circuits

Competency Builders:

Analyze hydraulic circuits
Troubleshoot hydraulic circuits
Analyze pneumatic circuits
Troubleshoot pneumatic circuits

Competency: Perform pump maintenance and repair

Competency Builders:

Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Perform pump maintenance
Disassemble a pump
Reassemble a pump

Competency: Maintain piping and accessories for high and low pressure fluid power systems

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of values and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join metallic pipe
Join plastic pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

Competency: Maintain hydraulic system components

Competency Builders:

Install a contaminant removal system
Maintain a contaminant removal system
Explain operation and use of heat exchanges
Identify reservoir requirements
Compute hose requirements
Install hydraulic lines
Select control valves and servo-type valves
Install control valves and servo-type valves

Competency: Troubleshoot hydraulic systems

Competency Builders:

Interpret hydraulic schematic
Identify causes of failure modes
Connect electrically controlled valves
Explain hydraulic system troubleshooting techniques
Repair or replace hydraulic valves
Repair or replace hydraulic cylinders
Repair or replace hydraulic pumps and motors
Install hydraulic components

Competency: Describe reciprocating and rotary air compressors

Competency Builders:

Explain relationship of force, weight, mass, and density in pneumatic system
Explain operation of reciprocating compressors
Explain operation of rotary compressors
Explain primary and secondary air treatment (e.g., air dryers, lubricating systems)
Explain operation of compressor valves, cylinders, and motors

Competency: Maintain pneumatic systems

Competency Builders:

Install pneumatic system components
Explain pneumatic system maintenance techniques
Explain pneumatic system troubleshooting procedures
Isolate faults in air compressors
Repair or replace air compressors
Isolate faults in control valves
Repair or replace control valves
Isolate faults in air motors
Repair or replace air motors
Isolate faults in air dryers
Repair or replace air dryers
Maintain proportioning and servo valves

Competency: Troubleshoot pneumatic systems

Competency Builders:

Interpret pneumatic schematic
Diagram an air supply system
Install pneumatic system components
Explain pneumatic system troubleshooting procedures
Troubleshoot air compressors
Troubleshoot pneumatic control valves
Troubleshoot air motors
Troubleshoot air dryers

Competency: Maintain vacuum systems

Competency Builders:

Describe characteristics associated with vacuum systems and sub atmospheric pressure
Describe the principles and operation of vacuum gauges
Demonstrate use of vacuum gauges
Repair or replace vacuum gauges
Describe the principles and operation of vacuum pumps
Demonstrate use of vacuum pumps
Repair or replace vacuum pumps
Describe the principles and operation of vacuum controls
Demonstrate use of vacuum controls
Repair or replace vacuum controls

Unit: Industrial Manufacturing Technology

Competency: Describe industrial manufacturing process

Competency Builders:

Demonstrate use and maintenance of personal protective equipment
Explain techniques of measuring motion, forces, voltage, current, power, distance, time and temperature
Explain mechanical and chemical properties of ferrous and non-ferrous metals
Explain industrial manufacturing process
Explain industrial use of non-metallic solids (e.g., ceramics, polymers), liquids, and gases
Develop flow chart and process sheets
Draft preventive maintenance and calibration procedures
Explain need for manufacturing documentation (e.g., ISO 9000)
Define quality process

Competency: Demonstrate knowledge of materials requirements planning

Competency Builders:

Define materials requirements planning
Explain importance of maintaining and controlling inventory (e.g., quantity, price, quality, minimal lot sizes, and timeliness)
Define master production schedule and bill of materials
Explain inventory carrying cost and economic order quantity
Describe the use of the computer in MRP
Calculate net requirements

Competency: Demonstrate knowledge of supply materials

Competency Builders:

Describe role of purchase requisitions
Describe role of material specifications
Describe role of quality parameters
Define supplier certification rating methods
Describe role of source inspector
Describe role of receiving

Competency: Demonstrate knowledge of plant layouts

Competency Builders:

Describe the importance of flexibility
Differentiate among product layout, process layout, fixed position layout, and cellular layout
Describe the type of production suited to each layout
Describe advantages and disadvantages of each layout

Competency: Demonstrate knowledge of material flow

Competency Builders:

Describe importance of flexibility
Differentiate straight-line, U-shaped, S-shaped, convoluted and comb patterns
Describe advantages and disadvantages of each pattern

Competency: Maintain quality control of materials handling

Competency Builders:

Maintain system for physical handling and movement of material in-process and in-storage
Monitor system of physical handling and movement of material in-process and in-storage
Maintain system for physical handling and movement of finished products
Monitor system of physical handling and movement of finished products
Write requests for deviation from specifications
Implement quality control and inspection standards and procedures
Write engineering change notices and rejection reports
Monitor reports of discrepancy or rejects during production process
Conduct quality tests under different environmental conditions

Competency: Demonstrate knowledge of post-production control

Competency Builders:

Explain importance of product protection, identification and storage
Describe methods of identifying products (e.g., labels, bar codes, radio frequency systems and magnetic strip systems)
Describe manual methods of storage and retrieval
Describe automated storage and retrieval systems (ASRS)
Describe automated guided vehicle moving systems (AGVS)

Competency: Analyze a manufacturing project

Competency Builders:

Explain the "how" of project selection
Explain the "how" of project implementation
Explain the "how" of project evaluation
Explain the "how" of planning continuing improvement
Explain the "how" of planning predictive maintenance

Unit: Programmable Logic Controllers (PLCs)

Competency: Differentiate among process controls

Competency Builders:

Describe characteristics associated with automatic controls
Define proportional control
Define integral control
Define derivative control
Describe advantages of using proportional, integral or derivative control
Describe disadvantages of using proportional, integral or derivative control

Competency: Explain basic operation of PLCs

Competency Builders:

Describe basic applications of PLCs
Identify program symbols and language functions
Describe function of block transfers
Describe operation of timers, counters, and sequences
Describe operation of analog I/O modules
Describe operation of servo motion control
Describe the principles and operation of PLCs

Competency: Demonstrate use of PLCs

Competency Builders:

Draw block diagram of a PLC
Define individual blocks of a PLC
Use operator's and/or manufacturer's manual(s)
Translate relay logic to logic for a PLC
Use function of block transfers
Operate timers, counters and sequencers
Operate analog I/O modules
Operate servo motion control
Install a PLC
Connect controller to sensors
Describe test procedures for new installation of a PLC
Troubleshoot hardware faults on a PLCs
Use safety interlock
Describe use of (Graphic Programmable Panel) GPP
Write a statement and ladder logic program
Document a statement and ladder logic program
Use a PLC program
Troubleshoot a program for a PLC
Repair a program for a PLC

Competency: Apply robot fundamentals

Competency Builders:

Describe the operation of robotic work cells
Operate robotic work cells
Troubleshoot robotic work cells
Repair robotic work cells
Classify robots according to industry criteria
Identify robot power drive types
Describe positioning in terms of axis, actuators and coordinate system
Identify types of control systems and sensors
Apply different methods of programming (e.g., teach, off-line)
Write simple programs to exercise robot functions
Join programs to perform full function
Identify principles of robot safety
Describe operation of various sensors used in robot control
Interface sensors to robot
Interface robots
Define open loop and closed loop control
Design a simple automated system to perform manufacturing operation
Identify operation of end-effectors

Unit: Computerized Numerical Control (CNC)

Competency: Demonstrate knowledge of CNC

Competency Builders:

Define numerical control (NC) and computerized numerical control (CNC)
Differentiate NC and CNC
Describe closed loop, open loop, and adaptive controls
Define point to point systems
Identify tool movement of point to point systems
Define continuous path systems
Identify tool movements of continuous path systems
Identify data input mediums
Explain the purpose of the post-processor
Define canned cycles
Identify computer memory types
Identify information stored relative to computer memory types
Differentiate hardware and software
Differentiate among CNC, machining centers, and robots
List advantages/disadvantages of CNC machining centers
Explain direct numerical control (DNC)

Competency: Perform preventive maintenance

Competency Builders:

Follow proper safety procedures
Clean CNC equipment
Lubricate CNC equipment
Check CNC equipment for wear and alignment

Competency: Apply CNC operations

Competency Builders:

Identify parts of the machine
Apply basic programming skills to a turning and a milling operation
Select proper work holders
Select proper cutting tools
Set machine parts to drawing tolerances
Use CAD/CAM for part program development

Competency: Prepare CNC program

Competency Builders:

Write a program manually in word address format
Write a program off line
Write a program manually in conversational program
Generate a program using CAD/CAM package
Program machine using manual data input (MDI) process

Competency: Program CNC operations

Competency Builders:

Apply ANSI drawing standards
Apply process planning from drawing to finished product
Analyze workpiece
Contrast differences in computer-assisted programming
Perform basic trigonometric computations
Perform special perception mathematical computations
Set chip load, feed rates and surface feet per minute limitations
Turn intersection points into segments (i.e., defined in terms of points, lines, and circles)
Debug program

Competency: Load machine

Competency Builders:

Load program from MDI and off-line programming station
Prepare work-holding device
Mount work-holding device
Secure workpiece
Set up reference and clearance points
Set up tooling
Select proper lubrication/coolant

Competency: Operate CNC machine

Competency Builders:

Load raw material
Start cycle
Monitor work in-process
Edit CNC programs
Demonstrate ability to halt running program
Apply proper safety procedures
Demonstrate proper cleaning of CNC machine

Competency: Manufacture workpiece (e.g., rectangular, round, angular)

Competency Builders:

Dry-run machine
Run part
Inspect part

Unit: Industrial Engineering Basics

Competency: Apply knowledge of workstation design

Competency Builders:

Participate in development of overall plant layout
Assure minimal movement of materials and parts throughout production line
Plan operator's access to materials and tools
Assure operator never reaches across moving machine part
Eliminate unnecessary body moves (e.g., bends, turns, stoops, hand movements)
Assure physical safety of operator (e.g., equipment, temperature, fumes, light)
List type of material handling equipment for operation
Calculate bench space needs for process and storage
Calculate machine controls to position operator efficiently
Physically simulate operation
Review total process for simplification

Competency: Demonstrate knowledge of ergonomics

Competency Builders:

Define ergonomics
Identify risk factors
Define maximum permissible limit (MPL) and action limit (AL) for lifting
Define cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Identify need for mats and footrest for standing jobs
Identify need for appropriate working heights of chairs, stools, workbenches, equipment
Identify need for adequate lighting
Explain use of anthropometric design
Explain use of rest pauses
Minimize extreme joint movement
Minimize use of excessive muscle force
Minimize repetitive tasks
Minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Minimize awkward body positions

Competency: Apply knowledge of methods engineering

Competency Builders:

Define methods engineering
Define goals of methods engineering (i.e., quality, increase productivity, decrease per unit cost)
Set sequence of production operations
Set sequence of needed inspections
Recommend methods to shorten process time
Recommend alternate operations
Recommend ways to eliminate operations
Ascertain if operations can be performed within facilities
Test machine capability
Follow documentation procedures

Competency: Apply knowledge of standards engineering

Competency Builders:

Estimate times by computer simulation
Use predetermined time system (e.g., MTM family)
Use work sampling
Define reach, grasp, move position, turn, apply pressure, and release
Define standard time
Define performance rating
Define allowances
Identify leveling factors (e.g., skill levels, effort, work area conditions, consistency)
Identify allowance factors (e.g., fatigue, delay, personal)
Calculate production rate
Write job description data
Complete job status reports
Analyze job evaluation data

Unit: Basic Materials Science

Competency: Demonstrate basic knowledge of metallurgy

Competency Builders:

Define metallurgy
Define metal forming (e.g., general process)
Identify forming industries (e.g., stamping, forging, fabricating)
Describe metal forming principles
Describe the metal forming process
Identify frequently used metals
Describe the crystalline structures of metals
Use periodic chart to evaluate metals
List chemical properties of common metals
List physical properties of common metals
Describe measures of metal strength
Identify examples of raw materials processed by hot rolling, cold rolling, forging, drawing, extrusion, spinning and powered metallurgy
Explain secondary finishing operations (e.g., paint, anodizing)

Competency: Demonstrate basic knowledge of heat treatment

Competency Builders:

Describe process of heat treating
Define types of heat treating (e.g., case hardening, annealing, drawing, stress relieving, tempering, quenching, critical temperature)

Competency: Demonstrate basic knowledge of metal characteristics and formability

Competency Builders:

Explain metal and formability basics
Explain metal grades and coatings
Explain part contour analysis
Explain tensile test
Explain LDH test
Explain bend test
Explain hold expansion test
Explain R-value test
Explain hardness test
Explain cup test
Explain friction test
Explain surface test
Explain interpretation of metal characteristics tests
Describe blank/die interactions (e.g., friction)
Describe friction and forming process
Describe circle grid basics
Describe circle grid applications
Describe formability diagnostics
Describe the documentation process

Competency: Demonstrate basic knowledge of casting

Competency Builders:

Identify frequently used metals
Describe crystalline structures of metals
Use periodic chart in evaluating metals
List chemical properties of common metals
List physical properties of common metals
Define permanent mold casting
Define shell mold casting
Define sand casting and pattern making
Define die casting
Identify basic casting terms
Identify advantages/disadvantages of casting processes

Competency: Demonstrate basic knowledge of iron and its alloys

Competency Builders:

Define iron and its alloys
Describe iron manufacturing process
Describe the structure of iron and its alloys
List chemical properties of iron and its alloys
List physical properties of iron and its alloys
Describe iron and alloys property variables
Describe measures of strength for iron and its alloys
Identify examples of iron and its alloys processed by hot rolling, stamping, cold rolling, drawing, extrusion, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: Demonstrate basic knowledge of aluminum and its alloys

Competency Builders:

Define aluminum and its alloys
Describe aluminum manufacturing process
Describe the structure of aluminum
List chemical properties of aluminum
List physical properties of aluminum
Describe aluminum property variables
Identify examples of aluminum processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: Demonstrate basic knowledge of copper and its alloys (e.g., brass, bronze)

Competency Builders:

Define copper and its alloys
Describe copper manufacturing process
Describe the structure of copper
List chemical properties of copper
list physical properties of copper
Describe copper property variables
Describe measures of copper strength
Identify examples of copper processed by cold rolling, drawing, extrusion, stamping, spinning, casting, forging and machining
Perform tensile test
Perform Brinell test
Perform chemical analysis

Competency: Demonstrate basic knowledge of plastics and polymers

Competency Builders:

Define thermo-analysis testing (e.g., melt flow, moisture control)
Define plastics and polymers
Describe plastics and polymers manufacturing processes
Describe structure of plastics and polymers
List chemical properties of plastics and polymers
List physical properties of plastics and polymers
Differentiate thermoset and thermoplastic
Describe plastics and polymer property variables
Describe measure of plastic and polymer strength
Identify examples of raw materials processed by machining, extrusion, stamping, injection molding, compression molding and injection compression molding
Identify molding defect (e.g., flash, sink marks, warp, contamination, wet material, stuck parts, short shot, burn marks, surface blemishes)
Identify secondary operations performed on plastic parts (e.g., plating, milling, painted)
Perform tensile test
Perform R-value test

Competency: Demonstrate basic knowledge of concrete and other ceramics

Competency Builders:

Explain concrete tools and applications (e.g., float, chairs)
Describe the formation of concrete
List types of cements and their uses
Define qualities of concrete (i.e., strength, consistency, homogeneity, tensile force, abrasion, heat of hydration, and heat and sulfate resistance)
List tests used in concrete production (e.g., slump test, test of fineness modules)
List protective practices used after pouring

Competency: Demonstrate knowledge of corrosion and protection

Competency Builders:

Identify causes of corrosion
Identify types of corrosion
List solutions to minimize problems
Identify corrosion testing

Competency: Demonstrate basic knowledge of rubber manufacturing

Competency Builders:

Explain history of rubber industry
Compare properties of natural rubber with those of synthetic rubber
Explain how natural rubber is manufactured
Explain vulcanizaton, mastication, and cure systems
Explain use of compounding ingredients (e.g., carbon blacks, accelerators, fillers, antioxidants)
Explain press and autoclave curing
Explain how synthetic rubber is manufactured (e.g., neoprene, butyl, styrene-butadiene)
Explain rubber testing (e.g., tensile, durometer)

Unit: Welding Basics

Competency: Perform basic gas welding, brazing, and cutting

Competency Builders:

Follow safety guidelines
Differentiate welding and brazing
Identify gas welding and cutting equipment and accessories
Use personal protective equipment required for welding and cutting
Explain capillary attraction as it applies to metal
Demonstrate proper lighting, adjusting, and shutting down of gas torch
Layout mild steel
Cut mild steel
Braze mild steel
Solder non-ferrous metals
Apply basic metallurgy technology

Competency: Perform basic arc welding/cutting (i.e., stick)

Competency Builders:

Identify arc welding equipment and accessories
Explain process of resistance welding
Explain process of projection welding
Explain process of flash-butt welding
Explain process of laser welding
Explain process of friction welding
Explain process of spot welding
Explain process of shielded metal-arc welding (SMAW)
Explain process of gas metal-arc welding (GMAW)
Explain process of gas tungsten-arc welding (GTAW)
Explain process of plasma-arc cutting
Explain process of carbon arc gouging and cutting
Explain process of welding plastics
Explain welding rod alloys
Read welding rods
Explain mild steel welding rod
Explain low hydrogen welding electrode
Explain rationale for preheating and post-heating metal
Explain (GMAW) welding in flat, horizontal, vertical positions
Explain (GTAW) welding on mild steel, stainless steel, and aluminum
Explain process of build up and hard facing
Troubleshoot fusion of materials
Weld stainless steel using (SMAW) process
Weld steel requiring preheat
Weld cast iron
Weld aluminum
Apply basic metallurgy technology

Unit: Metal Stamping Dies

Competency: Describe different types of dies

Competency Builders:

Describe crimping die
Describe parts assembly die
Describe CAM bending die
Describe blanking die
Describe pierce die
Describe forming die
Describe draw die
Describe progressive die

Competency: Describe fixtures

Competency Builders:

Describe crimping fixture
Describe locating fixture
Describe press fitting fixture
Describe riveting fixture
Describe welding fixture

Competency: Design product

Competency Builders:

Draw isometric view of product
Construct model (e.g., clay, form, wood, plastic)
Scan model
Wire frame data
Create computerized model
Interface model with CAD/CAM
Reproduce surface finish
Identify materials for product
Create prototype
Validate product
Standardize product

Competency: Troubleshoot design errors

Competency Builders:

Isolate cause of die component breakage
Isolate cause of failure of parts to be removed from die
Isolate cause of incorrect punch clearance
Isolate cause of incorrect die clearance
Isolate cause of misfitting die components

Competency: Correct design errors

Competency Builders:

Correct cause of die component breakage
Correct cause of failure of parts to be removed from die
Correct cause of improper punch clearance
Correct cause of improper die clearance
Correct cause of misfitting die components

Competency: Explain die processing

Competency Builders:

Describe preplanning activities
Describe die layout
Identify die operations (e.g., number, purpose and sequence of die operations)
Describe feasibility study development
Describe sequence of operations from die construction

Competency: Explain pattern shop applications

Competency Builders:

Describe pattern shop activities
Describe die pattern materials (e.g., wood, styrofoam, ceramic)
Describe die pattern construction
Describe casting of dies
Describe casting of components
Describe model process steps
Describe model use

Competency: Explain die construction (e.g., production and operation techniques)

Competency Builders:

Explain need for basic machining skills
Explain need for sculptured machining skills
Explain EDM functions
Explain die material standards
Describe tool and die welding
Describe punch finishing
Explain lifter/gauging systems
Explain pressure systems
Describe function of cams

Competency: Explain the die tryout process

Competency Builders:

Explain need to use analytical problem solving for die tryout
Describe process documentation
Describe die modification techniques
Describe blank modification techniques
Describe die buy-off
Describe die release
Describe part release
Describe die coatings
Describe die treatments

Competency: Explain die maintenance

Competency Builders:

Describe planned die maintenance
Describe predictive die maintenance
Describe preventive die maintenance
Describe die maintenance troubleshooting techniques
Describe die refurbishment techniques

Unit: Press Technology

Competency: Explain press operation

Competency Builders:

Identify types of presses
Describe functions of presses
Identify capacity of presses
Describe shuttheight
Identify operator safety devices

Competency: Demonstrate knowledge of press accessories

Competency Builders:

Describe function of monitors, proximity switches and die protection
Describe function of loaders
Describe function of roller levelers
Describe function of decoilers
Describe function of feeders
Describe function of transfer mechanisms
Describe function of lubricators and coolants
Describe processing of coil steel
Describe use of quick die change
Describe press set-up

Unit: Sheet Metal Fabrication

Competency: Demonstrate knowledge of sheet metal fabrication

Competency Builders:

Describe sheet metal fabricated products
Describe press working process
Describe process(es) of straightening metal
Describe metal finishing and coating
Explain bend allowances
Identify materials used for sheet metal fabricaton (e.g., hot roll, cold roll, aluminum, stainless)
Explain process of determining metal thicknesses
Explain process of layout
Explain process of fastening
Explain process of punch and die clearance and alignment
Demonstrate the capability to finish (cleaning, painting, plating)
Demonstrate CADD uses for layout

Competency: Describe types of metal fabrication manufacturing

Competency Builders:

Describe shear
Describe press brake
Describe cut-to-length lines
Describe roll forming
Describe CNC turret presses
Describe FMS cells

Competency: Layout sheet metal

Competency Builders:

Lay out 90° ells
Lay out 45° and 30° ells
Use radial line development to lay out
Use development by triangulation to lay out

Competency: Fabricate components

Competency Builders:

Layout design
Measure materials
Create pattern and/or prototype
Use hand tools
Cut materials
Form materials
Use fasteners
Spot weld

Competency: Perform sheet metal fabrication

Competency Builders:

Identify sheet metal fabrication jobs
Identify tools (e.g., manual and hand powered) needed
Fabricate round ells
Fabricate tees
Fabricate pyramids
Fabricate cones
Fabricate square to round transitions